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COMPOSITION OF COMMITTEE.

<u>Name.</u>	<u>Post.</u>	<u>Railway.</u>
F. A. POPE, (<i>Chairman</i>).		
J. A. BELL 	<i>Divisional Superintendent</i> E.I.
Lt. Col. C. F. CARSON R.E.,	<i>Divisional Superintendent</i>	... ... N.W.
R. C. CASE. ...	<i>Deputy Transportation Superintendent</i>	... G.I.P.
G. S. G. HIGGINSON.	<i>District Transportation Officer</i>	... ... B.N.
G. A. R. TRIMMING.	<i>Deputy Chief Mechanical Engineer</i>	... E.I.

Summary of conclusions and recommendations.

—	Pages.	Section and Paragraph.
Job analysis.		
1. Job analysis can be applied on Indian Railways with economy and it is recommended that it should be inaugurated on certain defined principles ...	3—7	2 (ii) & (iii)
2. Co-ordination of results of various analyses on different railways should be effected by periodical meetings of the officers engaged on the work. ...	7	2(iv).
3. If job analysis is inaugurated on railways not represented on the Committee, these railways should nominate officers to spend one month with an officer with experience of job analysis	7	2 (v).
4. Details of the lines upon which certain specific enquiries should be conducted are given as examples and in order that a measure of standardisation of method can be achieved. Job analysis is a matter of detail and may result in large economies in certain cases; but the main economy will be the aggregation of numbers of small savings	7—26	2 (vi).
Questions of efficiency and economy affecting all Railways.		
5. The importance of the question of intensive use of locomotive power is emphasized	27	3 (i).
6. Spare ground and accommodation should be scheduled, as it is considered that there are considerable possibilities, particularly in cities and large towns, of utilisation for revenue earning purposes. The Railway Board are asked to review the existing policy and thereafter address the Agents	27—28	3 (ii).
7. There are possibilities of economy by an organised scheduling of surplus equipment, track, and accommodation not only from the point of view of saving manufacture and purchase of new material or plant, but economy in maintenance. It is recommended that the Railway Board should address the Agents..	28—30	3 (iii).
8. Research and experiments are essential under modern conditions. It is recommended that the Railway Board should arrange the distribution of technical information on an organised basis and that they should make it known that organised and continuous research is of major importance ...		
9. The advantages to be gained from alterations to engines and rolling stock in connection with standardisation and improvements in design are important, but all administrations should be reminded of the necessity of satisfying themselves in regard to the stock position, before the alterations are effected, so that as little serviceable material as possible is scrapped	30—33	3 (iv).
	33	3 (v).

	Pages.	Section and Paragraph
10. Lack of co-ordination exists in regard to condemning sizes. After examination, standard instructions should be issued by the Railway Board embodying the most economical practices ...	33	3 (v).
11. Original design work has been done by Production Engineers on jigs, tools, and fixtures. Meetings of Production Engineers should be arranged to frame a co-ordinated policy to prevent overlapping, and incidentally to discuss latest workshop practices ...	33	3 (v).
12. Carriage and wagon hot boxes are increasing and are a serious operating and commercial inconvenience. A co-ordinated attack through the Indian Railway Conference Association is recommended...	34—36	3 (vi).
13. Economies can be effected if co-ordinated action is taken to ensure the fullest possible utilisation of scrap. Certain steps are recommended, including trial orders to ascertain the possibilities of using scrap tyres and axles for springs and permanent way fittings, the circulation of results of experiments, the establishment of Reclaiming Sections at Stores Department Depots, and the appointment of Sub-survey Committees at main returning centres.	36—38	3 (vii).
14. Management is facilitated by accurate and up to date costs. Compilation of all 'cost' and 'performance' data should be done by the Accounts Department for other Departments. Interpretation of this data is a matter for Agents and Heads of Departments. There is a lack of co-operation between the Accounts and other Departments which leads to managerial difficulties. An instruction to the Chief Accounts Officers to co-operate with the Agents and Heads of Departments is not sufficient. A fundamental change in responsibility is advocated: the Chief Accounts Officers should be definitely under the Agents except so far as certain statutory functions are concerned	38—42	3 (viii).
Owing to lack of uniformity in accounting systems in force in workshops in regard to unit costs of engine and rolling stock repairs, difficulties arise in comparing performances in one workshop with another. A small Committee of Works Managers and Workshop Accountants should be set up to effect standardisation of procedure in workshop accounting	42	3 (viii).
Retrenchment.		
15. There are numbers of surplus men on the railways to-day. These will be increased if the schemes for economy set down herein are carried into effect. Surplus staff means extravagance. New and improved methods result in reductions in man power in relation to work to be done. Increased business does not mean that the original complement of staff is restored. These points should be borne in mind whenever the Railway Board are considering any change in the retrenchment policy ...	42	4

—	Pages	Section and Paragraph
Finance.		
16. If railway plant and equipment is to be maintained in an efficient and up to date condition recognition of the principle of spending money to save money is necessary. The schemes for economy recommended will result in the preparation of many proposals, mostly of minor financial importance, based on this principle. Such financial arrangements should be made that the minimum delay will occur in effecting these savings.	43	5
Amalgamation of railways.		
17. The economies to be gained by amalgamations of railways in India are apparent. The importance is stressed of a detailed examination of the experience gained in Great Britain and Germany, so that a co-ordinated scheme can be drawn up which can be put into effect stage by stage	43	6
Conclusion.		
18. The whole tenor of the report is that it is only by constant organised research and investigation that improved efficiency and increased economy can be effected and that no saving is too small to be ignored.	44	7

*Copy of letter dated 25th February 1933, from F. A. Pope Esqr..
to the Chief Commissioner of Railways.*

REPORT OF THE COMMITTEE APPOINTED TO SUGGEST METHODS BY WHICH
EFFICIENCY CAN BE IMPROVED AND ECONOMY EFFECTED ON
INDIAN RAILWAYS.

In submitting to you the Report of the Committee under my Chairmanship, I wish to supplement what is contained in it by certain remarks :—

1. A large number of economies have been effected on Indian Railways, in common with railways elsewhere. There are no big individual avenues of economy left except the intensive use of locomotive power : no fundamental changes can be made now on Indian Railways to reduce expenditure except amalgamation : and both of these questions are referred to in the report. Considerable savings can, however, be made by detailed analysis of every operation conducted on a railway. To quote from the concluding para. of the report "constant organised research and investigation is necessary" and "no saving is too small to be ignored."

2. It seems to be the general impression that the Committee would examine the G. I. P. Railway in detail and suggest improvements in efficiency or savings which could be applied thereon, and to a greater or lesser extent on other railways. For the reason stated in the preceding paragraph (that increased efficiency and economy can only be obtained by organised and often lengthy investigation) this was not possible. In any event the characteristics and organisation of other railways differ from the G. I. P. and in comparison with each other. The report therefore deals with certain lines of investigation which can be undertaken by (a) individual railways and (b) the Railway Board, from the point of view of All-India. That large economies and improvements in efficiency can be effected by application of the principles advocated in the report, I have no doubt ; and this view is based on actual experience in Great Britain on a large Railway, which was certainly on broad lines not less well managed than the Indian Railways. The underlying principle was that advocated in the report, *viz.*, the creation of an additional arm of the organisation for investigatory work. It has been my experience that one idea or line of investigation, no matter how unpromising at first sight, often proves valuable, and often opens up unexpected additional lines of attack.

3. It is very important that as regards job analysis, periodical meetings of the officers engaged on the work shall be held, *vide* Section 2 (iv), page 7, of the report. No one individual or railway has a monopoly of ideas and most efficient methods : it is therefore essential to provide a clearing house to enable them to be widely applied. The principle of co-ordination of ideas also applies to other matters dealt with in the report in regard to which, as will be seen, it is recommended that the Railway Board should take action.

4. Reference has been made in the Legislative Assembly to the proposed appointment of an "Expert Committee" to follow on the work done by the Committee under my Chairmanship. In my view, no new Expert Committee is required. It is unnecessary, I think, to bring out any other "Experts" from

home. I should regard the officers, who were members of the Committee under my Chairmanship and who will now be engaged on the investigatory work as the "Expert Committee" and that is why I emphasized in the preceding para. of this letter that it is desirable that they should meet at intervals. There is no phase of railway working which, in due course, will not come within their purview and they will be fully qualified to act as an "Expert Committee". Moreover, I will maintain contact with the Committee, and they with me, so that ideas and information can be exchanged. Economies and improvements in efficiency can by this means be made known and adopted.

5. In conclusion I would emphasize again the fact that improved efficiency and increased economy can only be obtained by constant organised research and investigation. I would add that very many ideas of a detailed nature, but which nevertheless will lead to improved methods and savings in expenditure, have been discussed by the Committee. The report would have been still more voluminous if they had been included. These will be gone into when the members of the Committee return to their own railways.

REPORT OF THE COMMITTEE APPOINTED TO SUGGEST METHODS BY WHICH EFFICIENCY CAN BE IMPROVED AND ECONOMY EFFECTED ON INDIAN RAILWAYS.

1. INTRODUCTION.

The Chairman arrived at Bombay on 8th December 1932, proceeded to New Delhi, and there attended a meeting presided over by yourself at which the Agents of the State Railways were present. At that meeting it was arranged that the Chairman should make a short tour of the G. I. P. Railway, accompanied by an Officer of that railway in order to make acquaintance with local conditions, and that on 3rd January 1933, he should meet this Committee at Bombay so that (a) analytical investigations on the G. I. P. Railway could be inaugurated and (b) a report could be drawn up making certain suggestions under the above heading. These arrangements have been adhered to, except that Lt. Col. C. F. Carson, had unfortunately to go into hospital on January 11th. The Committee are unanimous in expressing their regret at his absence as his suggestions and experience would have been most valuable.

Many subjects have been discussed by the Committee, and in the succeeding paragraphs suggestions are made having for their object the introduction of methods which will, in their view, result in improved efficiency and economy.

2. JOB ANALYSIS.

(i) Description and objects.

Job Analysis is the term used by the London Midland and Scottish Railway to apply in general to organised departmental and inter-departmental analyses which have been carried out at the instigation of Sir Josiah Stamp. It means the measurement by exact methods, of staff and performance and of many diversified functions in different departments, and has resulted in extending mechanical and organisational changes successful in one class of operation to others, even in different departments, which at first sight appeared to be only roughly similar.

Job Analysis means the analysis of each individual item of work; its relation to other items; and the analysis of the work of particular individuals in order to discover whether particular operations—

- (a) are necessary in whole or in part,
- (b) can be amalgamated or co-ordinated with any other activity,
- (c) are being carried out in the most efficient and economical way.

Apart from these immediate aims, such analyses enable comparisons to be made between similar operations at different places with a view to determining the best practices. Analyses shew which operations may economically be carried out centrally and which operations should be performed locally.

A few examples of the directions in which these analyses have proved successful are given below :—

- (a) Maintenance of structures and track.
- (b) Handling of stores in main and subsidiary stores.
- (c) Handling of freight traffic in depots.
- (d) Shunting.
- (e) Operations in running sheds.

- (f) Materials, labour and operations involved in repair and manufacturing work in workshops.
- (g) Transport of materials in main workshops.
- (h) Simplification of clerical work (a) by concentration into offices joint to more than one department or (b) by dovetailing of inter-departmental contacts.
- (i) Review of work carried out locally, to ascertain whether central manufacture would be more economical.
- (j) Co-ordination of workshop facilities.

Apart from the results of specifically organised investigations, job analysis has resulted in many independent analyses being made, on their own account, by Officers in charge of large and small units of the organisation.

It is true that on Indian Railways, no less than on those in Great Britain, many analyses have been made; but the novelty in the scheme now being described lies in the fact that job analysis is an organised drive of a specialised type, and that its activities and results are co-ordinated, so that a line of attack developed, or an idea formulated, in one department can be applied in others. Job analysis is not intended, however, to dispense with the development activities of the departments themselves, or the full departmental responsibility for results.

Heads of Departments, Divisional Superintendents, and the Agents themselves for that matter, have not, as a rule, special staff to set aside to carry out *ad hoc* investigations. Job analysis aims at providing the management with a new arm or unit of the organisation to fill this gap.

Job analysis has resulted in many problems of inter-departmental relationships being solved which could not be tackled unless specifically organised. There are many questions which, even where a railway is organised by area instead of by department, affect more than one department. For example, there may be work carried out in the Civil Engineer's workshop on a division which, when analysed, will shew that it can be more economically carried out in a main Carriage and Wagon factory. Similarly, within a division, the Carriage and Wagon, or Locomotive Running branches may be better able to perform smithy work than the Signal or Civil Engineering branches. Again, even assuming that a railway is organised by area and not by department, headquarters must necessarily be split into departments, and, in any event, the Chief Accounts Officer's and Chief Mechanical Engineer's departments are outside the divisional organisation; so that there are many activities necessitating contact between either or both of these two departments and the area units.

A campaign of job analysis postulates recognition of the fact that an officer of one department, or branch of a department, may be able to suggest improved methods in another department. On the London Midland and Scottish Railway, for example, an official versed in the practices of handling traffic at a freight station, accompanied by an officer of the Stores Department, made very considerable savings in handling methods in Stores Depots. The principles of progressing work and shortening distances between one operation and the next, as applied in workshops, can be applied similarly to clerical offices. A Production Officer in an accounts office might effect a speeding up of the out-put by a close study of the progress of documents and inter-sectional contact.

A technique of investigation can be developed directed at providing departmental officers with forms, pointers, and methods for carrying out their own periodical analyses and for relating man power to the work to be performed. A simple

example will illustrate the point : forms have been drawn up for recording by a marks system the amount of work carried out in typing bureaux. These forms enable the ratio of staff to work to be tested periodically.

It has been found that although job analysis has been in force in an organised sense only for a short time on the London Midland and Scottish Railway it has resulted in a number of individuals being available who are the better for their training in analytical work, and, so far as the many matters of interdepartmental relationship are concerned, it has resulted in emphasising the necessity of problems being handled from the point of view of the railway as a whole. Furthermore, the management is gradually provided with a staff trained to investigate these questions from an independent standpoint.

Steel was developed by research : the cause of malaria was discovered by research. Many hitherto undiscovered means of efficiency and economy in railway working can be found by job analysis ; but like research it may be a slow process involving as it does the examination, sifting, and analysis of masses of details.

(ii) Job analysis recommended to be carried out on organised lines on Indian Railways.

The Committee have examined details of a number of analyses made on the London Midland and Scottish Railway. The Committee are of opinion that similar principles can be applied with economy to Indian Railways, and they recommend that job analysis on the lines set out in the following paragraphs should be inaugurated.

(iii) Application of principle of job analysis to Indian Railways.

The exact procedure to be adopted in inaugurating job analysis on Indian Railways will necessarily vary in consequence of differences in size, circumstances and organisation, but the following principles are suitable for general adoption :—

- A. *Job analysis must not be a fault finding scheme.* It aims at improving methods and effecting economy. If altered practices are introduced, this should not be regarded as a reflection on a Head of Department, Divisional Superintendent, or an Officer of lower rank. It is most important that this should be clearly recognised and acted upon, as otherwise distrust and obstruction will result, analyses will be delayed, ideas withheld, and keenness and the incentive to local officers to carry out their own investigations will be destroyed.
- B. *Job analysis must not be entirely a drive from the top.* The Heads of Departments, Divisional Superintendents, and other Officers must be impressed with its possibilities and should use it for improvement in methods in their own spheres.
- C. *The job analysis organisation must provide that pooling of ideas and coordination of effort are effectually achieved.*
- D. *To ensure that these principles are applied, the officer in charge of the work on a particular railway should be entirely independent,* that is to say, he should be a member of the Agent's staff. Direct contact with the Agent will only be necessary, or desirable (if principle B is to apply), in reporting progress, or in obtaining a decision when a Head of Department does not, but the Job Analysis Officer does, consider that a particular recommendation for improvement in efficiency or

saving in expenditure is worthy of adoption. The Agent will no doubt on occasions utilise the services of the Job Analysis Officer for specific investigations which he himself wishes to be undertaken.

E. It is essential that the staff engaged on the work should be specially selected for their tact and thoroughness, for two reasons :—

- (a) because on their tact will depend the propagation of the idea of analysis : and
- (b) because job analysis is a question of the proper sifting of minute detail and thoroughness is essential.

In connection with this point it should be realised that the staff required for the work will fall into two categories—those who are engaged full time on enquiries directly controlled by the Job Analysis Officer, either where two or more departments are concerned, or in investigations purely domestic to a particular department, and those who are temporarily detached from their ordinary work for a particular analysis. Furthermore, in some cases the staff engaged on the routine and often monotonous work of analysing a mass of detail to a schedule may be of low rank, working under the organising direction of a superior officer. In other instances, the investigator may, by arrangement with the local officials, obtain assistance either by a questionnaire to be answered by their staff or by the compilation of specially arranged details of future operations.

F. Reasonable commercial risks must be taken. This does not mean that the safety of passengers or of goods must be endangered by the introduction of cheaper methods of maintenance of track or less fool-proof methods of signalling. There are many other directions, in which, for example, traditional methods of check and counter-check can be modified. On page 26 of his Report on Accounting Methods in India, Sir A. Lowes Dickinson says, concerning codes, "they appear to have been compiled on the principle that whenever a mistake is found a new provision must be inserted.....". The amount of money recovered may be less than the cost of the check. Spot checks can often replace complete checks. If the spot check is artistically conceived and applied it provides, in many cases, an adequate safeguard. The question to ask is, "Can the railway afford a complete check ?" Checks mean delay : delay means inefficiency. The degree of check required on documents not connected with cash is not so high as that on cash itself. There are undoubtedly many documents which are checked at the originating point, again at the next point (which may be a different office in another department), and yet again at a later stage.

A different example of commercial risk is in connection with water supplies at wayside stations, which in India often involve expensive steam driven pumps. Assuming that there are watering stations 25 miles apart, an analysis of requirements may result in certain power installations being replaced by A-frame hand pumps which would be manned in the event of failure of a regular pumping plant. Another example may be quoted. The periods laid down for the inspection and examination of certain classes of machinery and plant are not always regulated in such a way as to meet the design and conditions under which they work. In some cases, e. g., motors, fans, etc., the examinations may be too

frequent and result in faults not coming to light and possible improvements in design remaining undiscovered. A lengthening of the period between inspections may have the double advantage of saving money and improving the equipment.

The Committee are unanimous in thinking that considerable economy can be secured by a wise application of the principle of taking commercial risks.

Turning now to the question of the detailed arrangements to be made on particular railways, the necessary preliminary arrangements have been made on the Great Indian Peninsula Railway, and a letter of instructions was issued by the Agent to the Heads of Departments of the G. I. P. (copy attached—Appendix). This sets out in some detail the objects of job analysis and the procedure to be adopted. With the exception of commercial risks, this letter makes reference to all the principles recommended in this report. In addition, the Agent has asked the Heads of Departments to nominate for selection as investigators qualified members of their staffs.

As regards the other railways, the following is an outline of the general organisation and arrangements recommended. These can be altered as required to meet local circumstances on any particular railway.

GENERAL.

As pointed out in para. 2 (iii) D, it is essential that the Officer in charge of job analysis should be an independent officer and work directly under the Agent.

His rank should be that of a Deputy Agent and it is suggested that his designation should be Deputy Agent (Methods), or (Organisation). He should operate through the medium of an organisation which will function under two heads :—

- (a) Advisory and co-ordinating.
- (b) Executive.

ADVISORY AND CO-ORDINATING.

The advisory and co-ordinating side of the organisation will function through a Committee consisting of Deputies of the various departments into which the railway organisation is divided, such as Operating, Way and Works, Power, Commercial, Accounts.

This Committee will be convened as necessary by the Deputy Agent, either as a full Committee, when subjects of interest to all departments are under consideration, or as a part committee when subjects of interest only to two or more departments are under consideration. In the latter event, only those Deputies of the departments concerned will attend, unless it is held that a useful purpose will be served by the attendance of all or some of the other Deputies.

The functions of this Committee will be advisory and consultative, and include—

- (a) Co-ordination of proposals concerning more than one department, which are inter-divisional or concern the railway as a whole,
- (b) Criticism of proposals concerning economy or efficiency under consideration by the Deputy Agent and regarding which he may wish for advice.

The avenue of approach to Heads of Departments when orders concerning inter-departmental matters outside the jurisdiction of a single Divisional Superintendent or Departmental Head are required will ordinarily be through this Committee.

The Deputy Agent will first refer the matter to the Committee and, when a measure of agreement has been reached, he will then represent the matter to the Heads of the Departments concerned, or through them to the Agent as necessary.

EXECUTIVE.

Broadly speaking, the analyses to be made will fall into two categories, *viz.*,

- (1) Analyses of functions which are purely domestic to one department or division, *e. g.*, shunting,
and
- (2) Analyses of functions concerning two or more departments or divisions, *e. g.*, one department undertaking work for another.

With regard to analyses in category (1), the Deputy Agent will make arrangements with the Head of Department or Divisional Superintendent for suitable staff to be temporarily released from their ordinary duties.

As to analyses in category (2), the Deputy Agent will make arrangements for the investigations to be carried out by the staff under his immediate control (see below), or will arrange with the two or more Heads of Departments or Divisional Superintendents concerned for suitable staff to be released temporarily from their ordinary duties.

PROCEDURE.

Reports of analyses in category (1) will be made direct to the Head of Department or Divisional Superintendent concerned, copies being sent at the same time to the Deputy Agent so that co-ordination can be achieved and the progress of the work recorded.

Reports of analyses in category (2) will be made direct to the Deputy Agent who will send copies to the Heads of Departments or Divisional Superintendents concerned.

DISPOSAL OF INVESTIGATIONS.

In the case of analyses under category (1) the Deputy Agent will maintain touch with the Head of Department or Divisional Superintendent concerned with a view to the recommendations being put into force. As regards analyses in category (2), the Deputy Agent will endeavour to co-ordinate the proposals as between the departments and divisions concerned with a similar object. In either case, if he cannot get agreement to a proposal, and is still of the opinion that the proposed improved method of efficiency or economy should not be abandoned, he may submit the subject to the Agent for decision.

STAFF.

The staff to be permanently attached to the Deputy Agent should be as follows:-

- One Junior Scale Officer.
- One Inspector, or Chief Clerk.
- One Stenotypist.
- One General and Record Clerk.
- Two Chaprassis.

It is suggested that this staff should be sanctioned.

It may be necessary to afford clerical and typing assistance as required from local resources to investigators engaged on analyses either in category (1) or (2).

ALLOWANCES TO JUNIOR SCALE OFFICER.

It is suggested that as the junior scale officer will be required to suffer many inconveniences inseparable from constant absence from headquarters and to incur expenses which ordinarily he would not be called on to meet, he should be given, in addition to the travelling allowances applicable to his rank, a personal allowance equal to the difference in pay which he would draw if promoted to his next higher grade.

In order to ensure that any officer, or subordinate, who has proved successful at job analysis, is retained on the work for the time being without loss to himself then or in his future prospects, if a vacancy to which he would normally have been promoted occurs in his department, he should be given that promoted rank, and the vacancy should be filled by a temporary promotion until he can resume his normal work in his department.

After such promotion, if he cannot conveniently be spared for the time being to return to his normal work, he will continue to draw the above personal allowance.

(iv) Co-ordination of activities for Indian Railways as a whole.

Just as experience has shewn on the London Midland and Scottish Railway the essential need of co-ordinating the results of the various analyses in different departments, or places on one railway, so that a good scheme, or method of analysis, developed in one sphere may be applied elsewhere, so is it necessary to provide means by which a similar pooling of knowledge, experience and results can be obtained by all railways which introduce job analysis.

Assuming that the recommendations contained in the previous paragraphs are adopted, the Committee recommend that —

- (a). One of the Deputy Agents should be nominated at the outset as Chairman, and after a period of say, 6 months, by which time experience will have been gained, he will convene a meeting of the other Deputy Agents.
- (b). At this meeting, the lines upon which investigations are proceeding on each railway will be discussed, and steps taken to agree upon a procedure by which an adequate exchange of information can be effected. At the same time arrangements for future meetings can be made as well as a measure of standardisation of methods of investigation established.

There is no need to have a co-ordinating Officer in the office of the Railway Board.

(v) Job Analysis on railways not represented on the Committee.

The Committee recommend that if the scheme is inaugurated on other railways, these railways should nominate officers who should, at the outset, spend one month with a Deputy Agent with experience of job analysis. There are so many matters of detail which have been discussed, ideas ventilated, practices compared, and so on, at the meetings of this Committee that it is especially desirable that before starting work the Officers selected should have the advantage of contact with one of the members.

(vi) Details of the lines upon which specific enquiries should be conducted.

The job analyses carried out on the London Midland and Scottish Railway were, of course, designed to apply to conditions in Great Britain which, in many respects, are widely dissimilar from those obtaining here. The Committee have, however, availed themselves of these in drawing up details of the lines upon which

certain specific activities should be analysed. We have included the following examples in this report so that not only will a certain measure of standardisation of method be achieved in investigating particular operations, but examples of the methods to be adopted will be illustrated for the benefit of those railways not represented on this Committee which may wish to inaugurate job analysis. It should be noted, however, that it is not always possible to draw up detailed methods by which particular operations, or inter-connected groups of operations, should be analysed: it must be left to the investigators to "job analyse" in their own way unfettered by particular terms of reference.

The very detailed nature of some of the analyses quoted as examples will, no doubt, be the subject of comment. The Committee wish to point out that job analysis is solely a matter of detail, and that, whilst it may result in large economies in certain cases, the main economy will be the aggregation of a number of small savings.

- A. Analysis of clerical operations.
- B. Examples of forms for analysing work of individuals.
- C. Job analysis of minor works and maintenance of equipment or structures.
- D. Lighting.
- E. Job analysis of a drawing office.
- F. Job analysis of the working of a goods station.
- G. Shunting analysis of a large yard.
- H. Job analysis in main workshops.
- I. Analysis of signalling equipment and train signalling methods.
- J. Analysis of individual items of signal maintenance.
- K. Analysis leading to intensive use of locomotive power.

In the succeeding paragraphs these examples of the application of the principle of job analysis are discussed :—

A. Analysis of clerical operations.

It is obvious that, for any undertaking, an efficient and economical clerical staff is desirable: that adequate systems of performing clerical work speedily should be in force: that repetition in recording information should be eliminated: and that information should be prepared quickly and correspondence handled without delay.

A cursory examination of many offices on Indian Railways shows that there is a general atmosphere of untidiness (which invariably results in inefficiency) and lack of system. Delay occurs in producing information and in handling correspondence. Draft letters often pass through too many hands with consequent loss of time.

The principle of progressing and scheduling work can be applied as much to an office as to a workshop. In large offices, a Production Clerk might be an advantage, whose duties would be to follow up every operation to see that it is being carried out according to plan, and that information is produced to time, and whose constant endeavour would be to speed up work, eliminate unnecessary work, improve lay-out, etc.

In some cases, offices joint to more than one department may be desirable. For example, at a big workshop, the offices of the Production Engineer, Workshop Accounts Officer, Stores Accounts Officer, and District Controller of Stores might be amalgamated with considerable advantage in the matter of speed of production of information, elimination of checks, and economy in clerical strength.

At Jamalpur, for instance, all requisitions which emanate from the Stores Depot are passed to the Production Engineer who makes out job cards for the shops concerned. On completion of the jobs the cards are returned via the Workshop Accounts Officer to the Production Engineer who in turn makes out 'the notes to the Stores, the documents finally passing on to the Stores Accounts Officer for the posting of the ledgers. All these four officers with their respective staff are within 200 yards of each other. If the whole of the staff was grouped in one office it is considered that economies could be effected.

An instance of improved efficiency by the application of this principle is given below :—

L. M. S. R. establishment of joint offices to deal with stores accounting.

The ledger transactions in the L. M. S. Stores Department approximate 12 million annually. They may be divided into :—

- (a) Issues from stock.
- (b) Receipts into stock.

Until the establishment of joint offices responsible to the Chief Accountant and Chief Stores Superintendent, and the introduction of mechanical ledger posting, considerable duplication was unavoidable while the respective officers carried out independently the functions for which each was responsible.

In connection with issues, the originating documents were priced from and posted into Stores Department ledgers by hand, and then passed to the Accountant, who had to allocate the expenditure on each issue against particular accounting headings.

In connection with receipts, the invoices from the Traders were checked for contract conditions, prices, discounts, etc., by the Stores and posted into the stores ledgers, afterwards being passed to the Accountant, made up into an abstract of payments, for him to certify and pay the Contractors. The Accountant also imposed a fairly extensive spot check on these invoices, and for this purpose was furnished by the Stores with a copy of all purchases, so that while the duplication might not be 100 per cent., it certainly existed to a marked extent.

In view of the necessity for economy, an impartial investigation of the position in the two Departments was carried out by representatives of the Chief Accountant and Chief Stores Superintendent, and it was quickly realised that much duplication could be eliminated by carrying out the work in one office jointly responsible to the two officers.

At the largest Stores the originating issue document now takes the form of a card which can be punched to indicate the stores catalogue reference for posting stores ledgers, and the accounting expenditure heading for allocation of charges. All that is necessary is for the documents to be passed through the mechanical sorter to sort into catalogue reference for producing the ledger, and then re-sorted into accounting expenditure code numbers to produce the expenditure statement. Both

ledgers and expenditure statement are produced mechanically. This system is only possible on two types of machines using punched cards, controlled by the British Tabulating Co. (Hollerith patents), and the Powers-Samas Accounting Machines Ltd., (Powers-Samas patents).

At the smaller Stores Depots the principle of joint offices applies, but the mechanical posting of stores ledgers and accounting expenditure is carried out on Burroughs' machines.

Apart from the greatly increased speed of ledger posting due to the introduction of mechanical appliances, savings became possible by eliminating the checking of prices, extensions, etc., on the issue tickets, which work was originally carried out by the Stores, and checked by the Accountant.

On the receipt side, the duplication in connection with the double checking of Traders' accounts has been eliminated.

Further savings have accrued by reason of the fact that accounting transfers, which were necessary when two separate offices were concerned are eliminated now the work is done in joint offices.

Some idea of the saving in this connection on the L. M. S. Railway may be obtained when it is stated that a reduction of no less than 33½ per cent. in the clerical strength has been effected.

It is not possible to lay down a standard formula by which analysis should be made, as the circumstances in different offices vary, but the following are certain points upon which an analyser should be satisfied in making an investigation into the work of an ordinary district office :—

- (1) Examination of all forms and statements, including statistical information, compiled to determine the purpose served with a view to recommending elimination and "marriage" of forms.
- (2) Combination of the typing work for all sections, with a view to a reduction in the number of typewriters now in use in each office. Are the typewriters all of one make?
- (3) Examination of the duties of men employed in miscellaneous grades, e. g. Messengers, as to their necessity in each case.
- (4) Elimination of unnecessary correspondence.

Can any copying work be saved by duplicating letters from one unit to another?

Can any matters or subjects be referred direct by Headquarters to District Offices and *vice versa* and thus save work in the Divisional Offices?

- (5) Method of ordering and storage of stationery.
- (6) Is the office accommodation and lay-out such as to permit the closest co-ordination between the sections?

Is it clearly laid down in standard instructions by what date particular information is required, and is there a system of seeing that it is produced to time?
- (7) Systems of registration and filing of correspondence.
- (8) Is there any other work besides typewriting which could be undertaken by lower graded staff than that employed at present?

FORMULA FOR ASCERTAINING CLERICAL STRENGTH REQUIRED.

" INDISPENSABLE "										
FORWARDING					DELIVERY					
No of consignments per day	Correspondence		No of Delivery Sheets			No of carriage notes issued at receiving station			Correspondence	
	Daily average No of new matters	No of clerks required	No of consignments per day	Provided by forwarded station	Issued at receiving station	No of entries in stock book	No of carriage notes issued at receiving station	No of special debits raised	Daily average No of new matters	No of clerks required
—	—	—	—	—	—	—	—	—	—	—

" INDISPENSABLE " —(contd)						" EXTRANEous ".			
ACCOUNTS.					STAFF AND STATISTICAL			OTHER STAFF REQUIRED.	
No of invoices to be abstracted.	No of items to be posted	No of deductions	No. of inaccuracies	No of Transfer Vouchers	No of clerks required	No of staff employed at stations		No of clerks required	Canvassers.
						Clerical	Super- visory		
*	—	—	—	—	—	—	—	—	—

- (9) Are the duties of each member of the staff clearly laid down? Do the clerks' duties consist of "general assistance as required", or relief; if so, can they be dispensed with? Have the Heads of Sections definite duties apart from supervision?
- (10) Is there any summarising of information or totalising of figures which can be done by mechanical clerical appliances with resultant economy or efficiency?
- (11) Work out the clerical man hours required purely for checking purposes.
- (12) If any technical staff are employed what proportion of their time is absorbed in clerical work?

As an example of the type of analysis that can be adopted for relating the clerical strength to the work to be done, a form (No. 1) is inset. This particular form refers to a Goods Depot, but can be altered and applied to other offices—such as those engaged in ledger posting—where a quantity of routine clerical work is performed. No special analytical staff is required; the analysis can be made by the officer in charge of the office.

B. Examples of forms for analysing the work of individuals.

Form 2 can be utilised generally for miscellaneous staff such as messengers, weighbridgemen, malis, chainmen, trolleymen, sanitary staff, etc.

A proportion of the staff may fluctuate according to requirements of traffic, but there are numbers of positions of a miscellaneous but fixed character such as those mentioned above, which cannot readily be adjusted in direct relation to the traffic. Form 2 can be compiled for about a week in each case, to show full details of the work performed. The forms will shew whether the whole of the work performed is essential, whether the individual is fully engaged in essential duties throughout the whole of his turn of duty, etc.

There are numbers of miscellaneous and non-productive grades, in proportion to the productive staff, in workshops, stores, etc. Analysis of the coolie strength in relation to the skilled staff might result in reductions of staff in the former category. The railways cannot afford to maintain what may be described as luxury men.

Form 3 is somewhat different from Form 2. It shows the kind of document which can be utilised to analyse the work of staff engaged on, say, inspection and maintenance of electrical equipment.

In both these forms, it is the analysis of the information on them, after they have been compiled, which enables unnecessary work to be eliminated, jobs to be combined, spare time utilised for other work, etc.

In the case of staff engaged on the maintenance of plant, it is necessary to schedule the equipment, review periodicity of examination, and relate the staff to the work to be done. Such analyses, in conjunction with records of failures and repairs carried out, may have a bearing on design, in that they will shew up the costs involved in maintaining particular machines or types of machines.

Analysis of operations should also include a review of the methods for reporting on the condition of structures and the factors governing decisions to carry out repairs or renewals, including minor repairs and jobbing.

Comparisons can be made of the man hours expended in carrying out similar duties at different places. Arising from these investigations, the location of small workshops may be found to be unsuitable. The compilation of these forms may bring to light the fact that technical staff are being employed for a part or even the whole of their time on work which, possibly by a little instruction, could be done by unskilled labour. For example, electricians may be employed for a proportion of their time on cleaning or replacing electric light bulbs : they may incur travelling or walking time in doing so, whereas at the place at which the lamps are located there may be staff of another department who could carry out the work equally well.

*C. Job analysis of minor works, and maintenance of equipment
or structures.*

Two specimen forms are attached, *viz.*—

Works Application Form (No. 4).—On this form the foreman or other officer applies for permission to carry out work. The form provides for entries to be made of the estimated materials required as well as details of the different grades of men and the estimated time they will require for the job.

Sundry Works Order (No. 5).—If the application for work to be done is approved by the District Engineer or other authority a sundry works order is issued to the foreman concerned. When this is compiled a carbon copy is taken on to a costing card on the back of which are columns for the actual wages and materials expended week by week.

These forms have been designed with the following objects :—

So that, except in cases of emergency, no work shall be carried out without prior authority, and in order that the necessity for the work can be investigated.

So that the estimated materials and man hours can be examined with the object of the work being done as economically as possible, both from the point of view of men's time and materials.

To provide a means of costing individual jobs and so that the actual cost can be related to the estimated cost.

To reduce the number of standing work orders.

Provided the original estimate is sound, this system is of assistance to the officer in charge in organising (*i. e.* programming), controlling, and analysing the work performed by his staff. The system outlined above can be strengthened by spot checks of works, large and small, to be carried out by the Resident Engineer or other technical Assistant. These spot checks should include an examination of the estimate to see that it has been carefully prepared and is reasonable ; a visit to the ground to see the work which has been, or is being carried out ; an examination of the time notes of the men and the methods adopted for carrying out the work ; and, if the estimate has been exceeded, or underspent, an enquiry into the reasons. It is, of course, essential that the individuals responsible for the estimate or for carrying out the work should be unaware of which job is to be checked. By these means, the possibility of inefficient supervision and organisation of work being covered up by artificial inflation of estimates can be eliminated, apart from the moral effect on the staff of such detailed enquiries. These spot checks should not be confined to the large jobs, which are more likely to receive closer supervision

FORM 2.

Station _____

Date _____

ANALYSIS OF WORK BY STAFF.

(1) Name _____ (2) Grade _____ (3) Rate of Pay _____
 (4) Time on Duty _____ (5) Time off duty _____ (6) Meal times { From _____ To _____
 " _____ "

Nature of work performed. (7)	Time commenced (8)	Time finished (9)	Time occupied. (10)	Detailed analysis of work performed. (11)

(12) General remarks.

Instructions for compiling form.

Column 2. Title of position to be shewn, e. g. Peon, Number-Taker, Messenger, Gateman, Mali etc.

" 4. To be the time booked on.

" 5. To be the time booked off.

" 7. Details of work performed. Examples :—

- (a) Invoice pasting or binding.
- (b) Collecting sheets.
- (c) Conveying of documents.
- (d) Number-taking, etc. etc.

Note.— Odd jobs, other than main duties, etc, to be briefly stated.

11. The information in this column must indicate the extent of the particular work shown in column 7, e. g.—

- (a) MESSENGERS To shew number of journeys between particular points and the approximate number of documents or packages conveyed i. e., invoice packets or consignment notes.
- (b) OFFICEMEN Sorting, pasting, or binding documents—approximate number of documents under each head to be shewn.
- (c) NUMBER-TAKERS ... To shew number of wagons recorded and points at which numbers were taken.
- (d) WEIGHBRIDGEMEN ... Number of weighings performed.



FORM 3.

Department.JOB ANALYSIS.

Details of duties etc., of Draughtsmen, Clerks, Foremen, Inspectors, and all other employees on the Wages Lists.

(a) Full Name _____ Age _____

(b) Home Station _____

(c) Grade _____

(d) Approx. hours Overtime or Sunday duty worked per month _____

(e) ,, ,, Night ,, ,, ,, ,, ,, _____

(f) State whether regular, temporary or casual employee _____

Usual duties—shewing approximate hours per normal week on each duty.

1. Description and Location of each duty.		Apportionment of Time.		4. Order No. or Dept. to which charged.
Description.	Location.	2. Actual time at work on each duty.	3. Actual travelling, walking or waiting time on each duty.	

FORM 4.

Order No. _____

Dept _____

District

Description of Works

WORKS APPLICATION FORM.

Date _____

Foreman _____

FORM 5.

Department.
District.

SUNDRY WORKS ORDER.

Charge to

Order No. _____ Date _____ To Inspector _____ Foreman _____ Station _____

Carry out the following work:

Reference to correspondence

Estimated cost Rs.

This order to be returned on completion of work.

Date of completion

than the small jobs scattered over a district. The aggregate cost of these small jobs may be considerable, and as the supervision is necessarily limited, the spot check on them should have relatively a greater value in minimising wastage than that on the larger works.

D. Lighting of railway premises.

A considerable sum of money is expended annually by every railway in electric current, gas, and oil for lighting. The lighting of a railway should be overhauled in all its aspects including :—

- (1) The installation of improved lighting, and the replacement of gas or oil lighting by electricity, where this can be done with economy.
- (2) * A close study of the siting of lamps with a view to saving in numbers, or an increased output of work in shops or offices.
- (3) * The siting and number of switches so that lighting temporarily not required can be switched off.
- (4) * Propaganda to save lighting, by exhibiting a notice near switches or taps requesting that lights should be extinguished when not required and stating the cost of an hour's illumination by that particular type of lamp.
- (5) * Examination of the work of the staff engaged on lighting maintenance and cleaning. The cleaning of windows and north lights with a view to reducing artificial illumination during daylight. To consider every instance where artificial light is used during the hours of daylight with a view to seeing whether natural lighting could be provided.
- (6) Can artificial lighting be reduced or eliminated by the use of whitewash or aluminium (or other light-coloured) paints?
- (7) * Whether adequate statistics of consumption of current, gas, and oil are available quickly after the period to which they refer, and whether they are split up, so that, for example, a station master or locomotive foreman can watch his own consumption.

E. Job analysis of a drawing office.

The following are certain lines of investigation to be followed in carrying out an analysis of the work of a drawing office. The analysis should have regard to the question of amalgamation of offices, and standardisation of practice and equipment.

- (1) Office copies of drawings. Quality of prints, i.e., calico instead of linen.
- (2) Drawings for shops. Is more than one copy sent into shops? How are drawings mounted? Can the method be cheapened? If drawings are mounted on boards and varnished, can varnishing be eliminated?
- (3) Paper for drawings. Can the descriptions of paper used be standardised and reduced in number?
- (4) Tracing cloth and tracing paper. Can existing cloth and paper be replaced by cheaper kinds?
- (5) Requisitions for materials for drawing office use. Is there any degree of standardisation with other departments and is there more than one ordering authority?

* These remarks apply equally to fans and punkhas.

- (6) Can duplicating machines be used for prints?
- (7) Issue of drawings. Are drawings stored under an efficient system of registration? Is issue easily made?
- (8) Tracings and drawings. Where only one copy is required, use carbon copies or paper tracings.
- (9) To what extent can graphs and diagrams now prepared be eliminated, simplified or reduced in number?
- (10) Are all designs approved in the rough before being finally traced?
- (11) What proportion of work done is wasted owing to estimates not being sanctioned?
- (12) Analyse work of each draughtsman and tracer having regard to possible alterations in procedure outlined above. Can certain work be done by lower graded staff than at present?

F. Job analysis of the working of a goods station.

It is not proposed here to consider the job analysis of small roadside stations. As a general example the job analysis will be taken of a comparatively large goods handling station, equipped with a goods shed, and a tranship shed, which are served by an adjacent marshallalling yard, such as is usually found at an engine-changing station on railways in India.

The staff can be divided into :—

- (a) Supervising.
- (b) Clerical.
- (c) Menial.

At a station of the above dimensions, the distinction between classes (a) and (b) above is not usually clearly defined. The goods clerk-in-charge or tranship clerk-in-charge does a certain amount of clerical, as well as supervisory work, and is, in turn, partly supervised by the station master. While therefore the whole of the goods clerk's or tranship clerk's pay can be allotted to the cost of handling traffic in the goods shed, it is also necessary to allot a proportion of the pay of the station master to the total cost. Organisation varies on different railways, and this proportion should be calculated according to circumstances.

The menial staff, i. e., the labour employed for actual loading, unloading or transhipping of goods, may be employed either directly by the Administration on a monthly pay or tonnage handled basis, or indirectly through a contractor. In the former case, their pay—as well as that of the clerical and supervising staff—should be directly related to the tonnage handled, taking into consideration questions of average handling lead, class of labour employed, and local rates of pay for similar labour in the neighbourhood.

An analysis of the work done can best be commenced by a questionnaire, which can be modified to suit local conditions. The following are suggested as questions which should serve to bring to light wastage of time or effort, and to establish a general standard of efficiency combined with economy.

OUTWARDS TRAFFIC.—

- (1) Is the road approach to the goods shed satisfactory, or does it cause a congestion of carts, such as to cause delay to loading and unloading?
- (2) Is the weighbridge, or scale, conveniently situated for free access and handling of consignments from cart to wagon?

- (3) Is the office organisation for rating and preparation of invoices satisfactory? Is the volume of traffic sufficient to justify separate clerks, or sections, to deal with rating, invoice preparation and collection of freight, or do you consider it practicable, in the interests of both economy and efficiency, to combine certain duties?
- (4) Is the lead for handling traffic between cart and wagon too long? Could it be shortened without undue expense or congestion of the platform?
- (5) Can the commercial staff assist the yard staff by loading wagons in grouped, or marshalled order, to minimise subsequent shunting in the yard?

INWARDS TRAFFIC.—

- (6) Can the yard staff assist the commercial staff by more systematised placing of inwards loads to save long handling leads, e.g., wagon loads in one place, and road-vans in another, or certain commodities in one place, and others in another?
- (7) Is there a definite system for sorting invoices on receipt for easy connection with wagons? Is there an organised link between the number-taker and the goods clerk for forward information of wagons to be placed in the goods shed, so that invoices can be sorted ready for connection?
- (8) Is a record kept of delayed deliveries, and the reasons for delay arising from unconnected documents, damaged consignments, delay on the part of the consignee, etc.?

TRAFFIC TO BE TRANSHIPPED.—

- (9) Are the dimensions of the platform suitable in both length and width?
- (10) Where there is no break of gauge, is repacking done on one side only of a long platform? Would a shorter platform with a track on either side be more convenient and shorten the handling lead?
- (11) Are wagons loaded with "smalls" in such a way as to be easily checkable? Is there any delay in the receipt of summaries?

GENERAL.—

- (12) To what extent can mechanical handling appliances, such as conveyors, runways, cranes, be utilised?
- (13) To what extent does the station master supervise the goods shed and tranship shed?
- (14) Do the yard staff serve the sheds at times convenient both to the commercial staff and to the train service? Has the best compromise between the requirements of both departments been effected?
- (15) Would any alteration in the layout of the yard result in a better service to the sheds?
- (16) What periodical returns are submitted by the goods clerk and tranship clerk to either Assistant Head of Department, Statistical Officer, or District (or Divisional) Superintendent? Are you satisfied that they are all necessary? What action is taken on them?

(17) Do you consider that any of the clerical work performed could be simplified or improved ? The following are suggested methods:—

If the volume of outward traffic is sufficiently heavy to justify separate invoicing clerks, would typewriters assist in more rapid, and more distinct, preparation of invoices ?

Is the volume of traffic sufficiently heavy to justify a procedure by which no summarisation or abstraction is done at the station at all, but is concentrated in the audit office, and carried out there by mechanical means ?

Could any of the various documents and registers in use be combined into a lesser number ? Is there any duplication, or unnecessary copying of information from one department to another ?

(18) Do you consider that the clerical staff is excessive ? What are the average man-hours (clerical only) to deal with 100 outward invoices ? What is the average cost of a clerical man-hour ?

(19) Do you consider that the menial staff to handle the traffic is excessive ? What is the cost per ton handled in the goods shed and tranship shed, separately, for each of the last six months ? What are the man-hours per 100-tons handled in each shed for each of the last six months ?

In the case of monthly-paid labour the above statistics will be compiled from the monthly salary bills of clerical and menial staff, including a proportion of the station master's salary.

For contract labour, the statistics will be compiled from the salary bills of the clerical staff, including a proportion of the station master's salary, and a twelfth of the annual amount paid to the contractor according to his agreement.

Information elicited from the above questionnaire should bring to light any wasteful, or uneconomic procedure, from a knowledge of which a measure of efficiency can be established for the station under analysis. In some of the more general questions definite conclusions cannot be drawn from the analysis of a single station. The analysis of one station may elicit information on procedure that will be useful to another. Particularly in clerical work performed subsequent to the actual handling of traffic there appears to be room for improved methods ; and where the volume of traffic at one station does not prove sufficient to justify the concentration of clerical work by mechanical means, an analysis of several large stations might produce a justification for dealing with the aggregate of this work by such means.

G. Shunting analysis of a large yard.

The following is an indication of the general lines on which an analysis of shunting in a yard might be carried out. It is assumed that the yard is large, but a modification of the procedure laid down could be applied to smaller yards.

The object of the analysis is to obtain detailed information with regard to the following points :—

- (1) The actual time spent by the various shunting engines employed on every operation undertaken by them throughout their periods of work.
- (2) The specific reason for and extent of each operation, and the actual work accomplished measured in terms of number of wagons moved per shunt.

- (3) The time spent by shunting engines on unproductive purposes, such as watering, movements light from one area of the yard to another, standing idle for reasons controllable, and uncontrollable, etc.
- (4) The numbers of supervising staff employed and the extent and necessity of the control exercised by them throughout their period of duty.
- (5) The numbers of executive staff and their specific duties ; also details of the operations they actually carry out throughout the period of their duty.
- (6) The details of the system of marshalling, sectionising and grouping carried out in the yard and the reasons, and whether these are satisfactory or can be improved.
- (7) The system and necessity of inspection by train examining staff of trains on arrival, during the process of shunting and before departure, with respect to the question of fitness of wagons to run, to be dealt with for defects on yard lines, on sick lines, or for transhipment prior to attention on sick lines.
- (8) Points relating to the suitability of the lay out of the yard and to the signalling arrangements relative to the various shunting movements required to be undertaken, and receipt and despatch of through trains.
- (9) Points relating to the correct location of facilities for shunting engine requirements.
- (10) Whether the normal time of arrival and departure of goods trains is suitable for the work to be done in the yard.
- (11) Whether any shunting operations are performed by shunting engines, necessitating light movements from one area of the yard to another, which could be performed more economically by train engines.
- (12) The actual normal work done in the yard for 24 hours compared to its total capacity.
- (13) Cost of shunting per shunting engine hour and per wagon dealt with.
- (14) Obtain details of damages to wagons arising from shunting in the yard.

The investigating officer will specify the information under the various heads above which he requires to be collected and will lay down in detail how this is to be done. Ordinarily, the information will be collected in the following two ways :—

By means of tabulated statements issued to and filled in by senior supervising staff, supervising staff in direct charge of groups of illiterate staff, and by literate staff who themselves are employed on executive duties and who are competent to record the details of the various operations they perform during their periods of duty and the time spent on each.

By detailing suitable grades of literate staff to witness the operations of illiterate staff and record the work done by them throughout their periods of duty on suitable tabulated forms.

It is important that all details should be taken throughout the 24 hours or for as long as work is continued each day and that these records should be maintained for as many consecutive days as necessary.

Specimen forms (Nos. 6 & 7) which may prove useful as a guide for use in collecting information are inset.

The results should be examined under two main heads, *viz* :—

- (a) Matters which are particular to the yard in question and are independent of outside factors and which can therefore be dealt with at once such as :—

Use of excessive shunting engines for the work entailed.

Unnecessary movements, or movements which can be modified by a revised procedure or by a slight modification in the lay out of the yard, or facilities.

Excess staff, overlapping of duties, etc.

- (b) Matters which can only be rectified by co-ordinating the work done in other yards either on the same division or district or adjoining ones, or at originating points, and which, therefore, constitute "all line" questions and which require further analysis in other directions to arrive at final conclusions.

H. Job analysis in main workshops.

Main workshops may be classified under the two headings Locomotive Workshops and Carriage and Wagon Workshops.

The work done in these workshops may again be subdivided under Repair Operations and Manufacturing Operations.

With regard to repair operations, a very marked improvement has been effected during recent years as a result of the recommendations of the State Railways Workshops Committee and it is now possible to compare the cost of a unit repair on one railway with that on another, though unfortunately comparisons of this kind are vitiated by the fact that the accounting procedure on all railways is not identical.

UNIT COSTS

With regard to the unit cost of an engine, coaching unit, or wagon repair, an analysis on more detailed lines than is ordinarily undertaken should be made periodically to cover costs under labour, stores and general charges.

The analysis of labour figures will be considerably facilitated in view of the fact that, in most of the workshops in India, the gang system of working is in operation and this will enable each gang to be carefully studied in turn. All charges in connection with overtime should be scrutinised, as in many cases excessive overtime is due to faulty organisation.

The charges for stores should be analysed to see whether all charged off stores are being used or whether surplus material is being collected in the shop under review. Where sub-stores exist for charged off stores they should be examined, and all materials found in excess of actual requirements should be returned.

General charges are made up of items which cannot be allocated to any one work order. A comparison between general charges in force in various main workshops will indicate whether the percentage is too high, and the reason will usually be found in excessive coolie labour employed, or heavy demands for consumable stores.

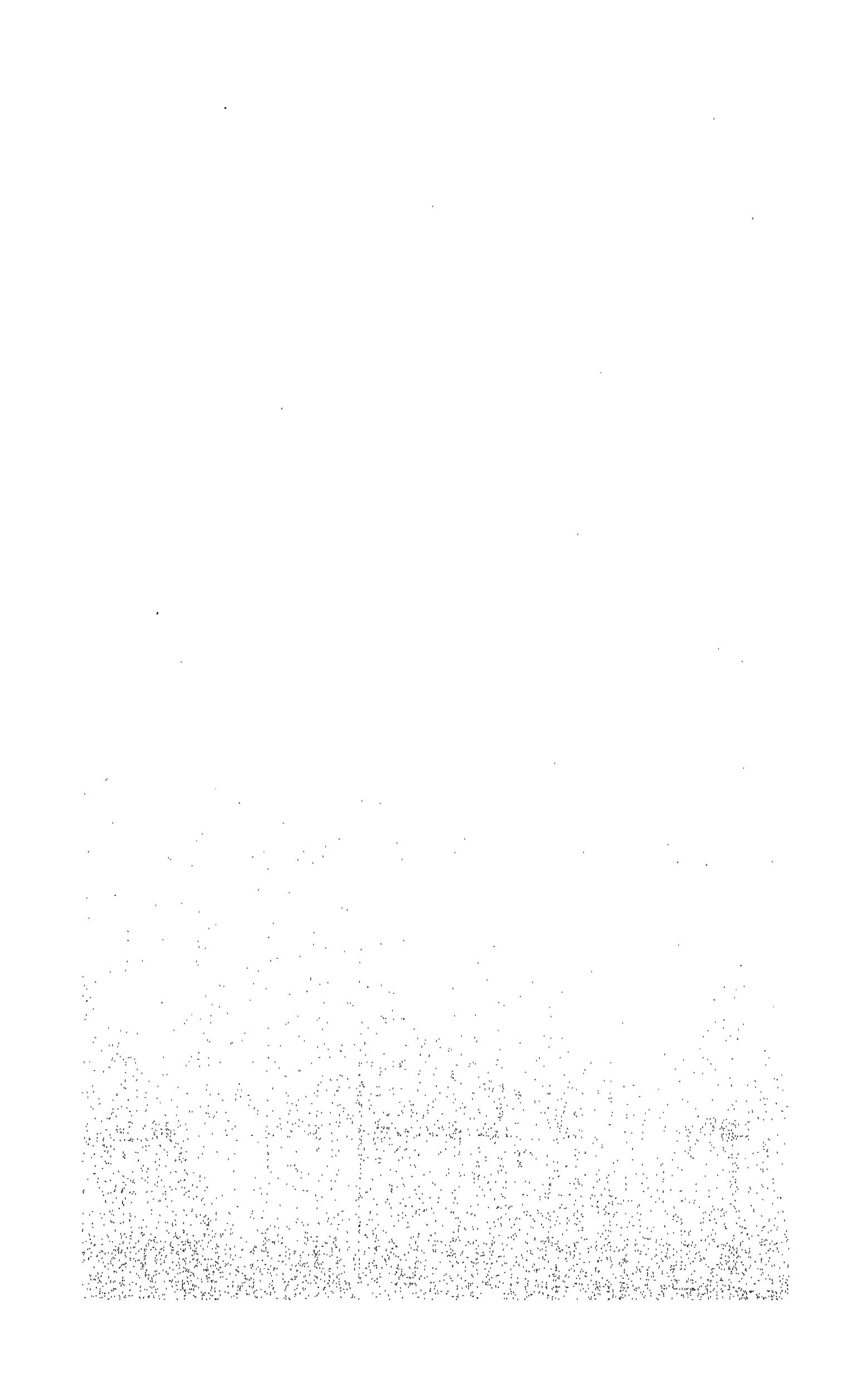
PROGRESSING AND SCHEDULING.

Nearly all the main workshops now have efficient progress and scheduling systems in force. These systems ensure that all operations are planned in advance and are progressed through the works to a time table. Master schedule boards

FORM 6.

ANALYSIS OF TRAFFIC DEALT WITH.
Particulars of wagons conveyed by.....

Time	From		To		Engine No and class	Time of arrival		
	Arriving	Leaving	Station day 19
Engine and Brake	Goods	Mineral	Empties	From	To	Railway and Route	Label Date.	
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
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Name of Side ENGINE HOURS.*

Grade.	6	Depart- ure from Loco. Shed.	Arrival at Traffic Sidings.	Depart- ure from Traffic Sidings.	Arrival at Loco. Shed.	Total.
Assistant Yard Master	..					H. M.
Yard Inspector	..					
Yard Foreman	..					
Leading Shunter	..					
Shunter	..					
Pointsman	..					
Yard Signaller	..					
Telephone Attendant	..					
Total	...					
						Total Actual Shunting ...
						Total Rostered Shunting ...

all Shunting Engines, also Train Engines rostered
ing.

Weather
State of Sidings.

Time.	STANDING.					28	29	30	31
	1 nes To and fro Reception Lines or Run- ning Round (c)	24 Water (from time engine ceases shunting to time ready to recom- mence).	25 Engine Duties.	26 Out of Work.	27 Detain- ed wait- ing Li- beration.	Total Time Shunting.	Total Time Standing.	No. of Wagons primarily shunted.	Man Hours of Shunting Staff.
6- 7									
7- 8									
8- 9									
9-10									
10-11									
11-12									
12- 1									
1- 2									
2- 3									
3- 4									
4- 5									
5- 6									
6- 7									
7- 8									
8- 9									
9-10									
10-11									
11-12									
12- 1									
1- 2									
2- 3									
3- 4									
4- 5									
5- 6									
Total	...	H. M.	M. H. M. H. M. H. M. H. M. H. M.						

SUMMARY OF

No. of Wagons primarily shunted.	No. of Wagons Shunted per Engine Hour.	No. of wagons primarily shunted	...............
		Engine Cost	Rs. a. p.
		Shunting Staff Cost	............
		Total Cost of Shunting	............

*Running between Loco. Shed and S.

Preparation (Cols. 1, 15) ...

Shunting (Cols. 2, 16) ...

Goods Shed and Departmental Shuntin

Internal Work (Cols. 3, 4, 5, 7, 8, 17, 18)

Standing (Cols. 9, 10, 11, 12, 13, 14, 23)

Waiting liberation (Col. 27) ...

* Shunting Engines only.

Total Engine Hours.

Shunting Engine Cost ...

Train Engine Cost ...

Total Engine Cost ...

Cost of shunting each wagon.....

MR R

will indicate where delays are occurring and it should be ascertained whether there are any sections where delays are frequent, as either new methods or additional equipment may be necessary.

REGULAR OUTPUT.

It is essential that scheduling and progress systems should cover the whole range of repair operations from the time a unit is received in the shops to the time that it leaves. A capable Production Engineer will balance his labour and his machines in such a way as to ensure a constant output. Assuming that there is an article which takes one hour to repair in one gang and two hours to repair in another, it is obvious that unless the strength of the second gang in men and machines is doubled, a holdup will take place; it follows, therefore, that the second gang should either be strengthened accordingly or should work a double shift. Unless this is done it nearly always follows that unnecessary overtime has to be worked to compensate for the delays which have occurred.

LOCATION OF STORES DEPOTS.

The location of the stores, sub-stores and scrap bins may merit investigation to see whether improvements can be effected leading to a reduction in handling charges. This is particularly applicable to certain shops which manufacture for stores certain items of which they are the principal consumers. In such cases it might be economical to provide a sub-stores under the charge of the Stores Department in the shop itself.

UNREMUNERATIVE LABOUR.

In referring above to general charges it has been mentioned that these can be seriously affected by having an excess staff of coolie labour and under this heading can also be included staff such as oilers, sweepers, messengers, watermen, etc. It is considered that analysis of their duties may reveal disproportionate percentages not only between main workshops but between different shops in one works. Modern handling appliances and road ways are now common features in most workshops, but it is felt that there has not always been a corresponding reduction in the coolie labour employed.

CLERICAL WORK PERFORMED BY TECHNICAL STAFF.

A profitable avenue of investigation in the workshops will be the clerical work which has to be performed by comparatively highly paid technical staff. It will be generally accepted that foremen, assistant foremen and chargemen should be relieved as far as possible of clerical duties so that they may devote as much of their time as possible to the actual jobs in hand. From time to time procedures have been brought into effect which may have disregarded this cardinal factor, with the result that the workshops are not obtaining that degree of supervision which the nature of the work demands. The better method is to analyse the procedure to see whether it is absolutely necessary for such work to be done by technical staff.

INSPECTION.

With regard to the economical use of materials it is essential that a thorough inspection of all parts should be carried out and that only those parts should be relegated to the scrap heap which are definitely not worth repairing. In a certain works, a Sub-survey Committee has been appointed which inspects all scrap heaps once a week with the object of checking the work of the inspectors. This system might be extended with profitable results.

WORK FOR OUT-STATIONS.

Repair operations in workshops are not confined to unit repairs alone. There is a vast amount of work received from out-stations and it is equally necessary that progress and scheduling systems should be applied to this, as the application of these systems will not only help to keep a check on the labour employed but tend materially to reduce the inordinate delays which are usually associated with supplies to out-stations. The cost of such delays is not reflected in the workshop accounts and it is not always realized that it is just as necessary to maintain a close check on repair operations for the Operating Department as it is on unit repairs.

In this connection it is believed that job analysis will reveal that, in certain cases, it will pay to instal better machines and plant in various sheds to obviate the transportation of large quantities of material which can be efficiently and economically repaired in sheds.

COST OF REPAIRS TO MACHINERY AND PLANT.

It will also be necessary to analyse the costs booked in workshops to the repair and maintenance of plant and machinery. In most workshops it will be found that the total is a large figure and, in certain cases, money may have been spent on repairing plant and machinery which should have been scrapped. On the other hand, it may be found that, owing to a cut in the allotment under this head, essential repairs have not been carried out, with a consequent loss in out-turn which nullifies the temporary saving effected.

Reconditioning of machinery has been taken in hand in certain workshops under a specialist, and provided a proper programme is framed and estimates insisted upon, savings can be made. It is good practice to have qualified staff employed on the constant inspection of machines.

MANUFACTURING OPERATIONS.

With regard to manufacturing operations, an attempt is now being made in most of the large workshops in India to apply job costing systems. Job costing, as the term implies, is the keeping of detailed costs of each operation on each job so that the final costs are available immediately the job is completed. Various methods of working this system are in force but the principles are the same ; namely, the accurate booking of all labour employed on each operation ; the correct allocation of all materials used ; and the final checking up of the total costs with the estimated figures which have been arrived at by careful time study.

Job costing, as will be seen above, is job analysis, and provided all costs obtained are maintained on master cards it is simple for the management to check whether the costs are rising.

TIME CLOCKS.

The correct booking of labour charges has always been one of the most difficult propositions with which a Works Manager has to contend. Generally speaking, the staff cannot be relied upon to book accurate times, and, human nature being what it is, bad working and idle time are frequently booked to wrong work orders. Time recording clocks under the charge of independent men belonging to the Production Department prevent malpractices of this nature and will ensure more accurate costs than are obtainable in any other way. The initial cost of time recording clocks can be offset by a reduction in the number of time checkers at present employed.

CASTINGS AND FORGINGS.

It will be found that job costing is generally applied only to items which require finishing. In the foundries and smithies it is customary to have work orders comprising a group of similar items—for instance, brake blocks, fire bars and floor plates might be grouped under one work order and all drop stamping under another. Whereas this certainly leads to simplification in accounting, it is obvious that true costs are not obtained, and it is recommended that work orders in manufacturing shops should be analysed and split up in such a way as to comprise in any one group all items costing approximately the same per cwt. or per unit. It seems anomalous to carry out job costing in such detail at a later stage when it is known that the cost of the castings and forgings as supplied is not the true cost.

The Railway Board referred to the Committee an important question of policy relating to the suggested central manufacture of certain standard castings. It was impossible to report upon this matter until costs on the principle mentioned had been compiled. If a decision had been come to by a comparison of the estimated costs of central manufacture and the costs of local manufacture based on the existing system of costing by groups a serious error might have been made.

ECONOMIC BATCH ORDERS.

We believe that job analysis will shew that some of the manufacturing plants in India are to-day working below capacity and there appears to be, therefore, every reason for co-ordination.

In manufacturing shops the principal difficulty in obtaining lower costs is the lack of regular orders, or of orders in insufficient quantities to justify the setting up of die blocks, rolls, etc. It is difficult to make suitable arrangements if each railway is treated as a separate unit, but there can be no doubt that economic batch orders could be arranged if the requirements of Indian Railways for such items as standard castings, standard drop stampings, springs, etc. were co-ordinated. We are aware that the Railway Board have already taken up the question of the mass manufacture of certain castings, but it is considered that there are numerous other items which might profitably be reviewed, not only from the point of view of cheapness of manufacture, but from the wider aspect of closing down plant which is working below capacity, and making intensive use of the existing plant at a suitable centre.

I. Analysis of signalling equipment and train signalling methods.

For the purpose of an analysis of signal equipment a simultaneous analysis of train passing and train signalling methods is necessary. In other words, economy can be effected not only by (a) simplifying methods of safeguarding the receipt and despatch of trains, into and from a station, and of movements within the station limits, but also by (b) simplifying methods of safeguarding the passage of trains between stations.

Under (a) the lay-out of the actual signals themselves can roughly be classed as that applicable to receipt and despatch of trains at (i) stations on a double line, (ii) stations on a single line, and (iii) to movements within the limits of such stations.

Under (b) there are various systems, such as lock and block ; the absolute block system with various kinds of electrically worked instruments for the provision of an authority to proceed ; the train following system ; the train staff and ticket system, etc.

The general object of this analysis is to determine under (a) whether the system of the lay-out of signals at stations is unnecessarily expensive, i. e., whether it provides too great a margin of safety for local conditions ; whether it is complicated to an extent that entails the employment of unnecessary staff ; whether it handicaps free movement within the station limits without providing any greater margin of safety etc., and under (b), whether the system in force on various sections of the line is the most economical, compatible with efficiency and safety. Co-ordinating (a) and (b), i. e., whether the general system in force over a section, or sections, of the line is capable of revision to suit the volume of traffic, and fluctuations of traffic, over the section.

SIGNALS FOR RECEPTION AND DESPATCH OF TRAINS.

The lay-out of reception and despatch signals at stations working under similar conditions does not vary greatly in principle on sections where the volume of traffic is sufficiently heavy to justify interlocking. The main difference is naturally to be found in the lay-out for stations on double lines and for stations on a single line. The system of interlocking may vary, and often does vary, on different sections of the same railway, although the local conditions are similar.

In such circumstances, the reasons for the variety of systems require examination. One system may be unduly expensive in materials for maintenance, or staff for operation, compared with another ; the cost of standardisation should be carefully compared with saving accruing, not only from the installation itself of the most economic system, but also from the standardisation of material necessary for general maintenance.

SIGNALS TO CONTROL INTERNAL MOVEMENT.

The lay-out of signals necessary to control movements within the limits of a station must necessarily vary according to the local conditions of work to be done in the station. In the larger yards particularly, an analysis of the signalling arrangements may show an unnecessarily expensive system, in that free movement has been sacrificed to too great an extent to safety. It may show that the yard is so interlocked that the simplest movement is restricted and that an unnecessarily large staff is maintained to operate points and signal levers for movements that could be adequately controlled by free semaphore signals, or even by hand signals. It may also bring to light a multiplicity of signal cabins and lever frames in a yard, entailing the employment of separate shifts of staff on each, instead of the concentration of work into larger cabins more centrally situated.

SYSTEMS OF TRAIN SIGNALLING.

The cutting out in this manner of small cabins, or lever frames, in a yard can be applied in a somewhat similar manner to systems in force for controlling train movements between stations. The justification for (say) doubling a certain section of the line is dependent on the capacity of the dominant block section, and is then applied to the section as a whole. It does not follow, however, that every station on that section requires the same equipment of double-line signals and signal-cabins. One station may require two cabins, one to control each end of the yard—at another, a centrally situated cabin may be sufficient to control both ends of the yard. An analysis of the train movements at each station, and of the line capacity of the section as a whole, may show that economy can be effected by reducing the number of cabins at certain stations, either by establishing a central control, or by making one a master-cabin to the other with the employment of high-graded staff only in the master-cabin.

A further examination of train movements on a double-line section may elicit the fact that for certain lengthy periods there are no passenger trains booked to run, and that no goods trains are booked to stop between certain consecutive stations. In such circumstances an investigation would be justified into the necessity for, or the correct interpretation of the General Rule on railways in India that the normal condition of signals is "On", and the General Rule that signals must be put back to danger after the passage of each train. There might be justification for closing down cabins and leaving signals permanently lowered during such periods.

On single lines the usual system of passing trains is the absolute block system, with either electrically worked instruments to provide an authority to proceed in the shape of a token, or table, or telegraph instruments by the operation of which a written authority to proceed is prepared. Stations may be equipped with interlocked signals and points, or may be non-interlocked and worked with outer signals only, according to the volume of traffic to be carried.

An examination of the traffic carried relative to the line capacity, may show, that equipment in the shape of electrical block instruments, or interlocking, or both, originally installed to provide the necessary facilities to deal with a certain volume of traffic, are now no longer necessary in whole, or in part, owing to a fall in the traffic.

The absolute block system itself on certain small branch lines may be unnecessary, and possibly a source of undue delay in cases of failure of electric instruments. It may be found that the installation of the train staff and ticket system between the terminals of a branch line, with intermediate flag stations, is more economical without prejudicing safety.

On single-line sections where it may be found convenient to lengthen block sections by leaving signals lowered at certain consecutive stations during periods of slack traffic, or of one-way traffic, investigation would be necessary into means of cutting out, or switching through, block instruments, and revised rules would be necessary to safeguard train movements adequately.

SUMMARY.

Summarising the above general lines on which analysis is possible, there are two broad headings under which practical results can be obtained :—

(i). Economy in operation of existing equipment by analysis of traffic movement, so that, by switching through or cutting out signal cabins, block sections can be lengthened during periods of slack traffic, and line capacity reduced to correspond with traffic requirements, with a consequent reduction in the cost of operating facilities which provide too high a line capacity during such periods.

(ii). A systematic and organised review of signal facilities on each section of line to see whether a simplified equipment, taking modern developments into consideration, would effect economy.

It would be necessary, if analyses on these lines are to be conducted satisfactorily, for an Operating Officer and a Signal Engineer to work in co-operation.

J. Analysis of individual items of signal maintenance.

A considerable amount of work is undertaken annually by the outdoor staff of the signalling department with respect to which a system may be required of checking the actual work done compared with the man hours expended.

The list of operations given on form No. 8 (inset) are merely for purposes of illustrating the method to be followed.

Each signal inspector or assistant signal inspector would prepare a list of the operations to be performed by the various gangs and individual men working under him on every work undertaken over a given period, say, a month. The recording of the times taken would be done by the Mistris, etc., in charge of particular gangs.

These statements would be handed over on completion of the works to which they relate to the inspector concerned, who would, after making any comments necessary, submit them to the Assistant Signal Engineer.

By a comparison of the results obtained from similar operations on different sections a correct appreciation of the adequacy of the staff employed could be obtained.

K. Analysis leading to intensive use of locomotive power.

In India, generally speaking, locomotives are allotted to crews, with the result that after every turn of duty the engines are laid off while the crews take their rest. Certain means are used in certain circumstances to minimise this loss of locomotive usage, but these means are generally in the nature of temporary expedients, and no useful purpose would be served in discussing them in this report. Under existing average conditions, passenger locomotives in this country, even when on mail and express services, can hardly exceed 6,000 miles/month, and goods locomotives 3,000 miles/month : many run less mileages. If locomotives could be used intensively, which means not only pooling them among the crews but running them on extended runs, it would immediately open up great possibilities. For example, passenger locomotives could run up to, say, 9,000 miles/month and goods locomotives up to, say, 4,000 miles/month : in fact, the mileage would be governed by the limitations of the time table rather than by the limitations of the engines. This would lead directly to a material reduction (in the region of 25% on certain services) in the number of engines required, and this in turn to an equivalent reduction in interest, depreciation, and other charges incidental to the ownership of engines. In addition, there would be other practical and financial advantages of very considerable magnitude affecting simplicity of operation, closing down of locomotive sheds, reduction in the cost of fuel and repair bills, obsolescence and so on.

The financial and practical advantages of increasing materially the miles/day/ locomotive in use would be comparable in importance with, for instance, those following upon the introduction of super-heating of steam, the introduction of statistical control in 1924-1925, or the reform of workshops following upon the Raven Committee's report. It is not surprising, therefore, that a number of attempts have been made to reap these advantages. Unfortunately, up-to-date in India, these attempts have not been crowned with any great measure of success.

It is not intended in this report to touch upon the technical aspects of this question except to mention that the technical and practical difficulties to be overcome are formidable. These difficulties are lessened, but not by any means removed, by improvements in design incorporated in the latest types of IRS engines : but if intensive usage is to await the purchase of large numbers of such engines it will obviously be impossible to advance on a large scale for many years

*This subject is of major importance, and from this point of view, should have been included under that section of this report dealing with all-India questions. It has been included here because the scheme is based largely upon job analysis.

District.

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MAN HOURS PER UNIT OF WORK.

Actual work engaged on :—

No. of men employed :—

Total time taken (Effective and Ineffective.)

Details of Work	Time per Unit (Man Hours)				Details of Work	Time per Unit (Man Hours)			
	Effective		Ineffective			Effective		Ineffective	
	Hrs	Mins	Hrs	Mins		Hrs	Mins	Hrs	Mins
INSTALLING SIGNAL 1-ARM COMP. SITE.									
DETAILS OF WORK									
1. Digging out hole for concrete foundation—									
Ballast									
Hard soil									
Soft soil									
Debris filled formation									
Black cotton soil									
Ashes									
Hard moorum									
Kunker									
Lime stone not blasted/blasted ..									
Sand stone " " " "									
Trap									
2. Placing of forms for foundation—									
(a) Placing and fitting									
(b) Levelling and centring									
(c) Placing anchor bolts and protecting nuts									
3. Preparing concrete—									
(a) Measuring ballast, sand and cement									
(b) Bringing water									
(c) Spreading									
(d) Mixing									
4. Making foundation.—									
(a) Carrying concrete									
(b) Tamping									
(c) Finishing off found									
(d) Watering									
5. Opening out ballast for guy ropes.—									
(a) Under rails									
(b) To place through sleepers for lifting and guys									
6. Erecting signal—									
(a) Placing wood packing on found									
(b) Placing base and pole									
(c) Placing pole on found ready for lifting									
(d) Tying guys									
(e) Running lifting tackle and fixing same									
7. Fitting up signal 1-arm—									
(a) Fitting ladder complete									
(b) Fitting arm spindle and lamp bracket and pinnacle									
(c) Fitting spectacle, back blinker and stop									
(d) Fitting arm									
(e) Fitting balance lever bracket and clamps									
(f) Fitting and adjusting down rod									
(g) Fitting wheel and wire rope sling									
(h) Fitting shackle and signal wire to balance lever									
8. Painting signal—									
(a) Rubbing down with wire brush									
(b) Painting pole 2 coats									
(c) Painting fitting 2 coats									
9. Cleaning up—									
(a) Coiling up ropes									
(b) Spreading soil from foundation hole and levelling up									
(c) Packing up tools									
(d) Replacing ballast removed for fixing guys									
10. Carrying material and gear to site—									
11. Carrying material and gear from site—									
12. Miscellaneous ineffective time—									
Travelling to station									
Waiting for line to be blocked									
Meal times									
Drinking water time									
Travelling from station									
Protecting operations									

EXAMPLES OF METHODS FOR COMPILED TIMES.

Item. Effective time to start from.

Digging out hole for concrete foundation. From the first spit of earth dug.

Making foundation From time filling of forms commences.

Preparing concrete From time mixing starts.

Erecting signal From time signal is in position on ground, but the fixing of guide ropes and/or erection of derrick etc. to be included in effective time.

Painting signal From time actual painting starts.

to come. Consequently, an attempt is being made on the Great Indian Peninsula Railway to utilise intensively the BESA types of passenger locomotives of which very large numbers exist in this country. If this attempt proves successful, the principles can easily be extended to include BESA types of freight engines and IRS types generally.

An attempt on the Great Indian Peninsula Railway to utilise BESA type goods engines intensively in the handling heavy traffic during the war period (1916-1919), ended disastrously, in common with other similar schemes on other railways on which the attack on the subject was based on what might be termed "traditional organisation", a system of organisation which admittedly produced excellent results under the less exacting conditions of the previous 50 years. The current attempt is based on the belief that a completely revised organisation is essential.

Only those whose life's work it is to 'keep the wheels turning' know that the locomotive is in fact, a delicately constituted machine liable to an astonishing variety of diseases requiring skilled and unremitting attention in their diagnosis and treatment. The preliminaries to successful intensive usage, upon which everything must depend, are first to classify these diseases, and then to devise means of preventing or curing them. The description below refers to a system of 'shed control' which has as its main object the classification of locomotive diseases. This system places in the hands of the executive an instrument of precision which enables the executive—

- (a) to trace the incidence of repairs and sources of engine trouble;
- (b) to follow the performance and cost history of each locomotive;
- (c) to determine the practical and financial effect of changes of policy on engine maintenance, e. g. increase of time table speed or train loading;
- (d) to determine the repair policy for any class of engines;
- (e) to trace leakage of shed labour;
- (f) to check efficiency of shed labour; and
- (g) to follow with facility the results of experiments or changes in design.

In short, the system enables the executive officer to decide instead of guess.

The introduction of such a scheme in a single large shed results in the executive being able to apply the results obtained to other sheds on the system, or to control these sheds with alternative and greatly simplified methods.

The method of working the shed control system is as follows:—

The Driver (or Inspector) responsible for reporting repairs enters them on Repair Card (A). The work is distributed to the repairing staff, who are divided into gangs specialising on certain items, by means of Job Cards on which are entered the details of the repairs required.

These Job Cards are returned after completion of the work and then show the work actually done (it is often other than that reported), the time taken, and the certification of the work by the supervising authority.

After calculating the man-hours and costs, the entries from the Job Cards are posted on the opposite side of the Repair Cards, and this side constitutes the Master Card (B). This Master Card is then punched to correspond with the Code. The Code provides for nearly

every item of repair required in a locomotive. [An example showing the sequence of these operations is given, Form 9. An examination of these reproductions will enable the method to be more clearly understood than pages of description.]

Repairs booked at outstations are entered on similar Job Cards. These are brought in by the driver with the engine and posted on the same Master Card as that on which he enters (on the reverse side) the additional repairs required at his headquarter shed.

The completed cards are filed in cabinets and sorted and analysed as occasion requires. To quote examples :—

- (1) Every month the repair costs of each engine are entered on Visualiser Cards, Form 10. The repair costs are arrived at by calculating the man-hours on a flat rate for each gang. These costs exclude supervision and other overhead charges. The gang rates are revised periodically. As it is necessary to express performance in terms of rupees it is necessary to express labour in rupees and not in man-hours.

The main object of this record is to establish trends of cost and performance upon which repair policy can be based ; for instance, to determine after what mileage various classes of engines should undergo intermediate or heavy classes of repair.

- (2) If at any time it is desired to trace the history of any experiment, the details are carded out and the facts recorded on Forms 11 & 12.
- (3) Every six months complete analyses are made of selected series of engines in Form 13 with a view to determining, among other things, the incidence of repairs and man-hours of labour entailed for each of the coded items of repair.

These analyses are summarised as shewn, Form 14, and serve as a valuable check upon the progress made during the period concerned in eliminating or reducing repairs.

Experience will teach that the closer even the smallest details are scrutinised the easier becomes the solution of the multifarious problems that arise in organising engine power suitably for intensive usage. To quote a single striking example :—

Analysis of the drivers' bookings on connecting rod big end bearings disclosed the fact that their incidence was in the region of 1,460 miles per bearing. Apart from enabling the executive to devise minor improvements which extended the mileage of the existing bearings to about 2,420 miles per booking, it led to the application of an experimental design of bearing which is still running and, up to now, has run no less than 70,000 miles without any-maintenance attention whatever.

4. QUESTIONS OF EFFICIENCY AND ECONOMY AFFECTING ALL RAILWAYS.

There are a number of questions of efficiency and economy that have been discussed by the Committee which affect all Indian Railways and, in their view, require to be dealt with not as a part of the operations of a particular railway, but as national matters. These are as follows :—

- (i) Intensive use of locomotive power.
- (ii) Utilisation of spare ground and accommodation for revenue earning purposes.

OF A.)

FORM 9.

OUTSTATION JOB CARD FOR BOILER STAFF (YELLOW)

Cost of Mudhole Joint Rings on Reverse

PROCEDURE.

JOB CARD FOR MACHINE SHOP (WHITE)

(a) Repairs booked by Driver on arrival referred to Job Cards. Material, if QB and sent for machining (if any), done entered on Job Card and certifies to brasses and Straps.

(b) Job Cards costed and particulars coded, totalled and nipped.

Filed in cabinets by Engine Type as summarised at end of month. Summarised on Visualiser Card.

Analysis of coded items taken out every week, as required, and summarised.

QB	GANG NO	TICKET NO	HOURS	RATE	Rs				TIME & DATE	
Brasses to End Strap		2336	1	35	-	3	1	F	JAN 25 12-05	(A)
							2	S	JAN 25 11-10	
		2561	4	35	-	11	3	F	JAN 25 5-00	(B)
							4	S	JAN 25 1-00	
Simpson, Letter Chg. 25/1		2336	1	35	-	3	5	F	JAN 25 6-00	(C)
							6	S	JAN 25 5-00	Brasses Machined and Fitted

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REPAIRS INSPECTED AND CERTIFIED BY S. D'GUERRA.

- (A) Marking off
- (B) Machining & Boring
- (C) Fitting in Strap

VISUALISER CARD.

Engine No. 1528.

Type D/5.

1932-33.	Mileage (monthly.)	Mileage (cumulative.)	Coal con- sumed per eng. mile (Lbs.)	Cost of Coal per eng. mile (Annas.)	Total Repair cost.	Cost of repairs.		Repair cost per eng. mile (Pies.)	Total cost per eng. mile (Pies.)
						Labour.	Stores.		
APRIL.	6776	37364	51·1	5·2	Rs. a. p. 117 7 0	Rs. a. p. 74 0 0	Rs. a. p. 43 7 0	3·3	65·7
MAY ...	6174	43538	49·4	4·8	287 15 0	101 4 0	186 11 0	9·0	66·6
JUNE ...	2233	45771	55·9	5·5	121 10 0	49 4 0	72 6 0	10·4	76·4
JULY ...	6284	52055	51·0	5·2	146 15 0	79 11 0	67 4 0	4·4	66·8
AUG. ...	6174	58229	55·7	5·8	161 3 0	100 3 0	61 0 0	5·0	74·6
SEP. ...	5646	63875	60·3	5·8	123 0 0	64 13 0	58 3 0	4·2	73·8
OCT. ...	5646	69521	60·3	5·7	151 4 0	80 8 0	70 12 0	5·2	73·6
NOV. ...	6276	75717	62·8	6·2	284 7 0	101 3 0	183 4 0	8·7	83·1
DEC. ...	6211	81928			287 14 0	115 11 0	172 3 0	8·9	
JAN. ...									
FEB. ...									
MARCH									

FORM 11.

INSTRUCTION SHEET.

Locomotive Experiments.

Index Letter MN
Words Coupling and connecting rods.

Reference No. of Experiment.... E. A. I. G.I.P. — 7 Drawing No.
EXP. 1

Date of experiment No. 6-10-30.

Letter references... W. M. PR's E. 289 J dated 1-9-31.
C. T. S's XYZ dated 4-9-31.

Description. "X" system of grease lubrication on coupling
and connecting rods, and soft grease on
motion and other pins.

Date report should arrive in ... After 120,000 miles, or earlier if necessary.
C. T. S.'s Office.

Division concerned Bhusaval.

Stock concerned... Engine No. 430 D/4 type.

The application of grease lubrication to coupling and connecting rods
needs no longer be considered as an experimental alteration, but it is
necessary to continue the experiment of soft grease lubrication on other
motion.

The object of the experiment is to determine whether, from
maintenance and running aspects, the application of soft grease to motion
is to be preferred to oil lubrication.

Special notes.
Object of Experiment.
Form of Report.

The report should incorporate the following
information :—
Cost of engine repair on a mileage basis of parts
concerned as determined from the shed control
system.

FORM 12.

REPORT.
(In Duplicate).

Locomotive Experiments.

Index Letter MN
Words Coupling and connecting rods.

Reference No. of Experiment—EAI GIP 7
EXP 1 dated 6th October 1930.

Report by Divisional Transportation Superintendent, Bhusaval Division, dated 10th October 1932.

Description:—"X" system of grease lubrication to coupling and connecting rods and soft grease to motion and other pins re-fitted.

Engine No. 430 completed its mileage (100,000) without any intermediate overhaul and was returned to Parel Shops with the original big end brasses and coupling rod bushes fitted in Shops at the last general repair, with the exception of one big end brass, which was renewed due to fracture on account of a sand hole, and one L. D. coupling rod bush which was renewed in April 1932.

No case of a heated big end or coupling rod bush occurred throughout the mileage run by this engine and the result may be considered as very satisfactory.

Statements of mileages, repair costs and lubrication costs are attached.

Date	Mileage run	No of days worked	Cost of lubrication	Cost of repairs	Remarks
1930.					
December ..	2921	19	...	...
1931.					
January ...	5984	24	...	...
February ...	5610	24	...	...
March ...	5657	25	...	...
April ...	7106	29	...	...
May ...	6396	28	...	...
June ...	1393	11	...	...
July ...	272	11	...	...
August ...	4068	18	22 9	67 11	Labour only.
September ...	6540	25	42 15	61 2	
October ...	6556	28	50 3	47 0	
November ...	6328	29	39 4	55 0	
December ...	6667	29	38 10	69 6	
1932.					
January ...	3304	14	23 6	115 1	Labour and Stores.
February ...	6370	26	31 4	118 0	
March ...	6398	30	48 11	115 12	
April ...	7295	29	52 4	186 7	
May ...	9479	30	63 15	205 15	

Cost of repairs per engine mile ... } Rs. 741.3
(January 1932 to May 1932.) } $\frac{32,846}{32,846} = 43$ pies.

Cost of lubrication per engine mile... } Rs. 413.1
(August 1931 to May 1932). } $\frac{63,005}{63,005} = 13$ pies.

Note.—Figures of cost (labour and stores) have been taken from Shed Control System.
They exclude overhead charges.

Engine No. and Type	Mileage.	Code number and index. B	A
D/4.402	36,179		
403	18,783		
404	29,907		
405	22,723		
407	10,760		
412	30,842		
413	29,497		
414	35,541		
416	28,569		
419	17,607	G	
424	21,373		
425	26,692		
430	33,058	G	
1352	29,406		
1354	15,125	FB&G	
1355	15,488		
1357	30,010		
1359	16,461		
1361	16,641	G	
1362	23,165		
		Total.	
D/5.1516	35,886		
1517	27,102		
1518	26,925		
1519	29,240		
1520	30,515		
1522	30,475		
1523	21,348	FB	
1524	16,658		
1525	17,512		
1526	16,432		
1527	29,577		
1528	37,133		
1529	28,700	FBL	
1530	10,894		
		Total.	
		Grand Total	

Recapitulation of totals computed half yearly.

Total jobs on all coded items.	Total man hours recorded.	Man hours per 1,000 miles run.	Mileage since last heavy repairs. (1000s.)
489	2577	71.2	46
295	1443	76.8	23
366	1923	64.0	68
204	999	44.0	26
241	1110	103.0	84
383	1880	69.9	49
422	1711	68.0	33
667	3119	87.0	60
370	1417	49.0	57
289	1348	76.0	78
324	1390	65.0	79
398	1787	66.0	72
615	2231	67.0	90
367	1427	48.0	29
250	1397	92.0	111
320	1701	109.0	94
587	2632	87.0	77
190	1056	64.0	86
189	868	52.0	55
322	1722	74.0	18
7288	33738	..	..
573	3231	90.0	47
618	2562	94.4	64
461	2890	107.3	96
519	2500	86.8	95
492	2634	86.3	70
447	1997	65.5	31
273	1527	71.5	100
258	1290	77.9	61
213	1220	69.6	122
291	2004	124.5	86
590	2815	95.1	76
516	2414	65.1	37
525	2322	80.1	56
190	903	82.8	44
5966	30239	..	..

G. Grease lubricated bearings.

F.B.G. Floating bush big ends, grease lubricated.

G. Grease lubricated bearings.

F. B. Floating bush big ends, oil lubricated.

F.B.L. Floating bush big and little ends, oil lubricated.

FORM 14.

	PRIMARY DATA.					PASSENGER.	GOODS.
Total mileage	11,30,536	1,95,328
No. of engines	46	15
Period of time	6 months	6 months
No. of man-hours	82,456	18,169

**Distribution of labour expended on repairs booked on
BESA types of locomotives.**

			PASSENGER.	GOODS.
Knuckle pins	...	..	0·68	1·10
Ash pan and dampers	...	...	0·69	0·40
Tender springs	...	...	0·92	0·71
Valve gearing	...	..	0·93	0·63
Regulator	...	..	1·10	0·62
Top clacks	..	..	1·20	1·70
Lubricator	..	..	1·30	2·90
Tender axle boxes	...	..	1·50	1·10
Engine stay plates and wedges	...	..	1·90	1·53
Little ends	...	..	2·07	3·50
Cylinders, steam and exhaust pipes	...	..	2·30	5·03
Side rods	...	..	2·40	2·58
Engine springs	...	..	3·70	2·80
Bye pass valve and pressure valve	...	..	3·90	2·60
Piston valves and sleeves	...	..	4·20	3·28
Slide bars	...	..	4·40	4·01
Pistons	..	..	5·40	5·42
Injectors	..	..	5·60	7·40
A. V. B. cylinder pipes ejector	..	..	6·80	6·20
Connecting rods big ends	...	..	8·02	8·60
Engine axle boxes	...	..	8·10	7·09
Balance—all other items	..	..	32·89	30·80
	Total	..	100·00	100·00

- (iii) Surplus machines and other equipment, redundant track, and the relation of maintenance to requirements.
- (iv) Experiments and research.
- (v) Miscellaneous items in connection with main workshops.
- (vi) Carriage and wagon hot boxes.
- (vii) Utilisation of scrap.
- (viii) Accounting as an aid to efficiency.

These matters are dealt with seriatim in the succeeding pages :—

(i) Intensive use of locomotive power.

This question is of great importance, but as it is based largely upon job analysis it has been dealt with under para. 2 (vi) K (pages 24 to 26). The Committee wish, however, to emphasize its importance by including a reference to it here as an all-India question, and recommend that steps should be taken to inaugurate similar investigations on all railways.

(ii) Utilisation of spare ground and accommodation for revenue earning purposes.

The Committee are aware that for reasons of law or policy, the railways of India are not empowered to embark on certain schemes which it is considered might conflict with private enterprise. Nevertheless, it is their duty to draw attention to a direction in which additional revenue could be obtained, *i. e.* by the utilisation of spare land. It will illustrate their point better if certain instances of what they have in mind are given.—

A railway may have spare land alongside a station. If there is no reasonable likelihood of it being required for railway development purposes, attempts should be made to sell or let it.

A railway may have spare land alongside the railway in a big city. Here again, attempts should be made to sell it, or let it, either as a parking space for cars, or for any other purpose, including building.

There may be spare land in the form of embankments in or near towns, a roadway being parallel to or near it; the question should be examined to see if there is a possibility of erecting shops, flats or other buildings on it.

There may be road bridges over a railway in a town. Revenue might be obtained by building light bridge structures, on one or both sides of the road bridges, on which shops or houses could be erected.

There may be spare sheds which could be let out as warehouse accommodation. A spare waiting, or other room, might be let for commercial purposes.

An analysis of the use of retiring rooms at stations might shew that the accommodation could be reduced. This might enable a railway office rented in the town to be transferred to the station.

On the London Midland and Scottish Railway an organised drive has been made on this question with good results even in present circumstances of depressed trade and lowered standards of expenditure. Every piece of vacant ground has been, or is being, scheduled. Departments are consulted as to the likelihood of each plot being required in the future for railway purposes, and if not, steps are taken, either directly by the Company, or in conjunction with Estate Agents, to sell it, let it, build on it, or allow other parties to do so.

The Committee consider that there are considerable possibilities in the idea so far as India is concerned, particularly in cities and large towns.

If it is agreed that the matter should be explored, the arrangements to be made to schedule the spare ground will differ on divisionally and departmentally organised railways. On railways which are organised by area, the onus can lie upon the Divisional Superintendents to list the items of spare land on an agreed *pro forma*; but on railways departmentally organised, where two or more departments may be interested in a particular plot, the question might have to be dealt with rather differently—perhaps by entrusting a particular officer with the work.

With regard to schemes for new stations or rebuilding existing stations, careful examination should be made of the possibilities of providing shops, etc., in such situations that passengers entering or leaving have to pass them. A scheme for a new or remodelled station rarely shews a return on the outlay purely through increased economy in operation. A new or remodelled station on an existing site does not in itself produce increased revenue. Nevertheless, in the interests of progress and increased facilities for passenger traffic, it is often desirable to embark on schemes of this kind, and in order to obtain some return on the expenditure, it is necessary to obtain revenue from extraneous sources. An example from the United States will illustrate the point. The Boston and Maine Railway Company's terminal station at Boston (a city nearly the size of Bombay) required remodelling. They built a hotel building at one corner which was let to a hotel operating company. At the other corner they built an office which was used, partly to concentrate their clerical resources with economy, and partly to let out to different firms. A warehouse was erected along one side of the station; and over the roof of the platforms a concrete and steel stadium of simple and unpretentious design seating about 18,000 people was constructed. This is let out for circuses, ice hockey matches, band contests, religious, political and other meetings, etc. thus increasing passenger traffic. The passages through which passengers arrive and leave were lined with small shops. The whole scheme has earned a satisfactory dividend.

It is recommended that the Railway Board should undertake to review the existing policy, and thereafter address the Agents.

(iii) Surplus machines and other equipment, redundant track, etc., and the relation of maintenance to requirements.

The Committee have been impressed with the possibilities of economy by an organised scheduling of surplus equipment, track, and accommodation, not only from the point of view of saving manufacture and purchase of new material or plant but economy in maintenance.

Sections of track were noticed by the Committee which had obviously not been used for a considerable time. One of these, for example, included a turn out, the points of which were being periodically oiled. It is important to schedule every item of unused or seldom used track so that maintenance can be avoided or minimised and so that it can be taken up when required for use elsewhere, or for sale if the price of scrap is favourable. Owing to decreases or alterations in the flow of traffic, sidings at wayside stations, principal stations, or marshalling yards may become surplus. Some sidings which are used only occasionally might be rendered redundant by a slight rearrangement of working.

Lists should be compiled on co-ordinated lines of all spare machines, so that savings may be made by replacing an obsolete or uneconomical machine in, say, a transportation workshop by a modern machine spare in the main workshops.

Similarly, with furniture or office equipment; manufacture, purchase or hire may be avoided by strict regulations as to the declaration of spare tables, chairs, book cases, typewriters, telephones, etc.

A co-ordinated investigation might result in certain accommodation at stations, e.g., offices or waiting rooms, being listed as not required. These should be listed, even where such accommodation forms part of a station building, in order to save maintenance, lighting, and cleaning.

The periodicity of painting often depends, not on the preservation of wood-work, but on considerations of policy such as amenities for passengers. It therefore follows that some rooms in a station require less frequent redecoration than others.

These may appear to be small points—individually the savings may be small and not readily assessable—but in the aggregate the economy may amount to a considerable sum.

At the end of this paragraph a copy of a memorandum dealing with the question is given. The closest co-ordination between the maintaining and using branches of the organisation is required to give effect to the ideas set out therein. We recommend that the Railway Board should address the Agents of the railways on this subject.

Memorandum.

14th December 1932.

L. M. S. R.

*Review of maintenance expenditure on works equipment
or other capital assets.*

Until March 1932, the responsibility for reporting that any of the Company's assets were redundant and did not require further maintenance rested with the Maintaining Department; since then the responsibility has been placed on the Using Department with a view to diminishing the risk that assets are being maintained which are no longer required for the Company's business.

It has now been decided that in order to secure further economies in this direction as quickly as possible a small Committee, consisting of the District Engineer, the District Passenger and/or Goods Manager, and the District Controller will review the situation in each district. It is proposed that these Committees, in the first instance, should not make a very detailed examination which might last a considerable time, but that they should make a quick survey with a view to obtaining the more obvious economies at once. They will consider the facilities available in passenger stations, marshalling yards, branch lines, sidings and goods depots.

The Committees will take into consideration:—

- 1 the present use made of the track and accommodation ;
and
- 2 the probable future traffic and commercial requirements in respect of these items, bearing in mind the possibility of rearrangement of working facilities.

The Committee will then recommend, either :—

- (1) that the present standard of maintenance can be reduced ;
- (2) that maintenance should cease ;
- (3) that the asset should be dismantled or removed ;
- (4) that the present standard of maintenance is necessary or might, in some instances, need to be improved.

In some cases, no doubt, the maintenance economies would not entail entire removal, e.g. sidings not needed at present could be disconnected at the points, thus avoiding the employment of labour to pick up materials for which there might be little demand at the moment, whereas the siding could be readily brought into use after a temporary period of disuse if the traffic requirements again demand it.

Recommendations made in common agreement by the Committee will be reported to the Chief Commercial Manager and/or to the Chief Operating Manager, and to the Chief Engineer through the Divisional Engineers.

- (1) Recommendations to reduce the standard of maintenance to be put into force immediately, subject to the approval of the Chief Officers concerned, including the Chief Engineer.
- (2) Recommendations that maintenance should cease on an asset will be dealt with as (1).
- (3) & (4) Recommendations that assets should be dismantled or removed, or improved as regards their standard of maintenance, will be submitted to the Chief Commercial Manager, and/or Chief Operating Manager, who will advise the Vice-President, and, if approved, the Chief Engineer will be requested to give immediate effect to the recommendation.

Any necessary authority under the New Works Regulations in respect of recommendations 1, 2, 3 & 4, to be obtained through the usual channels.

The District Engineers will take the initiative in calling together the Committees and where the Engineering and Traffic Districts do not coincide, the District Engineer will deal separately with the Commercial and Operating Officers in the different districts which overlap his own.

(iv) Experiments and Research.

The Committee understand that, since 1929–30, financial stringency has been permitted to interfere with the progress of technical experiments. They hold the opinion that times such as these should be regarded as a valuable opportunity to glance around and review the possibilities of the future.

The obvious policy of any commercial concern should be to reconstruct and experiment in lean years so that the richest harvest may be garnered during prosperous years. A wise directorate should earmark reserves for such purposes ; and a number of shining examples of such wisdom exist in the commercial world to-day. Reconstruction during prosperous years often leads to extravagance owing to the over-optimism which such periods tend to produce. Apart from any other consideration, it is a well recognised axiom in railway and other industrial circles that “if you stop progressing you start sliding back”. The wide-spread and evil psychological effects of a stagnant policy upon the staff are obvious ; and conversely, the energy and enthusiasm engendered among the staff by a strongly directed policy are equally noticeable.

The Committee confine themselves to a few suggestions only—there are scores of possibilities—along which technical investigations should proceed.

Motor manufacturers give new designs exhaustive bench and road tests before committing themselves to a new design—their very existence depends upon it. The thorough testing of a new design of locomotive is a comparatively long process. It may be possible to detect and eliminate weaknesses in certain details after running, say, 50,000 miles; but there are other portions of the design, in the boiler, frames and so on, which may require a much greater mileage to bring weaknesses to notice. It is obvious that a new design is not a matter lightly to be embarked upon at short notice.

Unless steps are taken to experiment upon these lines railways will be faced with two alternatives :—

- (a) the purchase of numbers of engines incorporating features which are out of date,
- (b) the purchase of numbers of engines incorporating up-to-date features which have not been tried out fairly exhaustively in practice.

Both alternatives are costly; much more costly than the purchase annually of a limited amount of experimental equipment. It may be that additional locomotives or equipment may not be necessary at the time, but a long view should be taken, and it is suggested that the Railway Board should reserve funds for the purpose and administer these funds in consultation with the various Agents of State and Company Railways. The Committee wish to emphasize that their intentions are not confined to experiments with rolling stock; they suggest that a similar progressive attitude should be adopted towards many other phases of railway activities.

It is necessary to sound a note of warning. No experiment of any magnitude should be undertaken till it can be shown that its progress can be watched in a scientific and properly organised fashion and results can be expected in a measurable time; and no experiment should be allowed to drop till it has been pushed to a conclusion.

There are many other problems, such as the use of new materials (e. g., nitrided and other wear-resisting steels), corrosion and its prevention, investigations such as were published in 1928 by the Bridge Stress Committee in England, the wind resistance of trains, wear of tyres and rails, lubrication phenomena, and so on, in which Indian Railways are vitally interested. It is difficult, if not impossible, to conduct investigations of this nature in India owing to a dearth of specialists and lack of facilities generally. But the German Railways have their own well equipped organisation for research; and the London Midland and Scottish Railway has developed a technique of research in which they have access to the best brains in the country. The Committee recommend that every endeavour should be made to associate Indian Railways (through the Railway Board) as active partners with either or both of these organisations.

Dealing with another phase of the subject of experiments and research, it may be pointed out that the Indian Railways are in a unique position in that competition between them is not of such a nature that any purpose would be served in withholding technical information from each other, or, in selected cases, even from commercial concerns. There is, therefore, everything to be said for giving the widest possible publicity among railway officials to the results of experiments. Such a course would not only stimulate enterprise, but would serve to eliminate much duplication of independent work. But whereas there is a willingness to spend

comparatively large sums upon educational schemes of various kinds, there appears to be some hesitation in spending money in the publication of technical literature ; a device of high educative value. To quote a few examples :—

- (1) The Indian Railway Conference Association decided "in the interests of economy" in 1931 to withhold temporarily the comparatively small prize given in their annual Essay Competition. (This matter has since happily been reconsidered.)
- (2) The Annual Administration Report on Indian Railways, Volume II, published by the Railway Board is a document abounding in information of great interest to railway officials. It should be found on almost every railway officer's table.
- (3) Reports such as that by Sir Arthur Dickinson, Technical Papers published by the Railway Board, Reports by Advisory Sections of the Indian Railway Conference Association and similar publications are hard to come by as far as the less senior officers are concerned. Yet these officers will some day have to control Indian Railways.
- (4) In 1931, one of the most elaborately equipped dynamometer cars in the world was delivered for use on Indian Railways. This machine has already enabled technical data of great value to be produced. Presumably because these reports contain charts, illustrations and tabulations that are relatively expensive to print, limited editions have been extemporised by typescript, ferro printing and photo-stat processes, so that, even in 1933, none of these reports has become available for officers other than those at headquarters.

The Committee recommend that—

- (a) every facility should be given to officers to obtain documents of this kind free of charge.
- (b) the Railway Board should undertake the collection of miscellaneous data that is not readily available in published Reports, for publication in the Quarterly Technical Bulletin.
- (c) accepted articles contributed to the Quarterly Technical Bulletin should be paid for at generous commercial rates. The possibility of securing advertisements should be explored.
- (d) technical literature, proceedings published by technical bodies and other documents should be listed, reviewed or summarised in the Bulletin for ready reference by readers, and information should be given, when necessary, on how best these papers can be obtained. The Bulletin should be recast in foolscap size, and each subject or contribution should be sectionalised and punched, so that not only could those interested take out sections for binding in loose leaf binders, but it would be possible for the Editor to supply sections instead of the complete Bulletin. It is recommended that the system should be modelled upon the sectionalised Proceedings of the American Society of Mechanical Engineers.
- (e) the Quarterly Technical Bulletin, or sections of this Bulletin, should be circulated free of charge to officers requiring them. Officers should be encouraged to circulate their copies among selected senior subordinate officers and to discuss with them the various problems of the day.

- (f) with regard to first portion of this section of the report (which deals with policy), the Railway Board should let it be generally known
 - (i) that they regard organised and continuous research and investigation as of major importance ;
 - (ii) that they must be informed of the problems which are being, or require to be tackled ;
 - (iii) that they will co-ordinate the procedure to be adopted ; and
 - (iv) that they will render financial assistance whenever possible.

(v) Miscellaneous items in connection with main workshops.

ALTERATIONS.

A considerable sum of money is expended each year on alterations to engines and rolling stock. These come under two headings—

- (a) standardisation
- (b) improvements in design.

The advantages to be gained from these alterations are so great that the Committee do not suggest any modification in the present procedure, but they recommend that all administrations should be reminded of the necessity of satisfying themselves in regard to the stock position before the alterations are effected, so that as little serviceable material as possible is scrapped. It might be found that, as a result, it would pay to defer alterations of certain items until existing stocks of parts are exhausted.

CONDEMNING SIZES.

A lack of co-ordination exists between railways in the matter of condemning sizes for engine and rolling stock parts. With a few notable exceptions such as tyres, journals, etc., there is no standard practice in regard to condemning sizes, with the result that certain railways are condemning particular items earlier than other railways.

It is suggested that a questionnaire to all railways calling for—

- (a) information on the practices obtaining in their workshops, and
- (b) recommendations for the introduction of condemning sizes in respect of items for which none are laid down at present

would result in useful data being obtained. The Railway Board might then issue standard instructions embodying the most economical practices.

JIGS, TOOLS AND FIXTURES.

A large amount of original design work has been done by the various Production Engineers on Indian Railways in connection with jigs, tools and fixtures.

While in no way suggesting that the initiative of Production Engineers should be curtailed, the Committee feel that quarterly meetings of Production Engineers should be arranged. At these meetings a co-ordinated policy should be framed for the following three months to ensure that there is no overlapping. The Committee see no reason why one Production Engineer should not undertake to design all the jigs required for, say, standard axle boxes, while another does similar work in connection with eccentric straps, and so on.

These meetings would have the added advantage of providing a means of discussing the latest workshop practices in connection with lay-outs, speeds, feeds, etc., and any other methods whereby economies could be effected.

The Committee recommend that detailed instructions on these lines should be issued by the Railway Board after consultation with the Agents.

(vi) Carriage and Wagon hot boxes.

The statement below shews that carriage and wagon hot axles are a source of serious operating and commercial inconvenience in that every wagon detected with a hot box requires to be taken out of traffic for changing the defective axle or bearing.

Table A.
All class I Railways.

Year.	Broad gauge			Metre gauge			Narrow gauge.			All gauges.		
	Carriage	Wagon	Total	Carriage	Wagon	Total	Carriage	Wagon	Total	Carriage	Wagon	Total
1927-28	912	26,784	27,696	456	4,044	4,500	24	108	132	1,392	30,936	32,328
1928-29	1,200	32,064	33,264	840	5,364	6,204	24	84	108	2,064	37,512	39,576
1929-30	1,128	36,828	37,956	960	5,748	6,708	12	96	108	2,100	42,672	44,772
1930-31	996	35,640	36,636	1,116	7,476	8,592	24	96	120	2,136	43,212	45,348

Note:—Later figures are not available. There is nothing to indicate that the position has improved up-to-date. The figures have been taken from the Railway Board Administration Reports.

The cost of attending to a hot bearing will necessarily vary with the amount of work to be done. In some cases it may be necessary to renew the axle and the bearing, in others the bearing will merely need remetalling. This refers to the direct cost involved; but there are many indirect charges which have to be added, such as delay to traffic, withdrawal of wagons from traffic, extra shunting engine hours, transhipment of loaded wagons, freight on wheels and axles and so on. A broken axle (due to overheating) on the Great Indian Peninsula Railway this year resulted in an accident estimated to cost Rs. 29,000; and this is by no means an isolated example. Taking into account the direct and indirect charges involved in dealing with a hot bearing it has been computed that the average cost for all gauges may be safely taken as not less than Rs. 10.

Translating the statement above into terms of money, hot boxes have been the source of the following annual expense:—

Year.	Rs.
1927-28	3,23,280
1928-29	3,95,760
1929-30	4,47,720
1930-31	4,53,480

Estimated at Rs. 10 per hot box.

It will be well, before attempting to decide a line of attack on this subject, to outline the history of events, and for the sake of simplicity and brevity, to confine attention to broad gauge railways' goods stock. Little, if any, technical advance has been made for many years in the design of axle bearings used on Indian Railways. Hot boxes have been so long in evidence in every day railway operation that the

tendency is, naturally enough, to regard them as inevitable concomitants of operation. The pooling of wagon stock, introduced in 1919, removed the problem from the direct control of individual railways and made it an all-India question. Up till 1924, the various railways manufactured bearing white metals according to their own specifications, but subsequently, a standard alloy was prescribed for use on Indian State Railways. It was decided in 1931, that the period between the overhauls of wagons in Mechanical Workshops should be extended from two to three years. The Indian Railway Conference Association arranged during 1930 for an all-India experiment in the lubrication of axle boxes ; but the results of this experiment were inconclusive. Large numbers of additional and independent experiments in lubrication have been undertaken by various railways : and recently, it was decided to accept kapas (unginned cotton) as a substitute for the considerably more expensive cotton waste used hitherto.

But to-day, trouble from hot boxes is no whit the less, as the table below shews, and it may increase still further as a result of the extension of the period between overhauls :—

Table C.

Hot Boxes per $\frac{10,000,000 \text{ coaching vehicle}}{1,000,000 \text{ wagon}}$ * miles.

Year	Broad Gauge		Metre Gauge		Narrow Gauge		All Gauges	
	Coaching	Goods	Coaching	Goods	Coaching	Goods.	Coaching	Goods.
1927-28 ...	8.00	12.6	7.92	4.90	6.58	3.10	7.95	10.4
1928-29 ...	10.2	14.9	14.4	6.47	6.27	2.20	11.5	12.4
1929-30 ...	9.41	17.7	15.4	7.03	2.87	2.50	11.3	14.5
1930-31 ...	8.53	17.9	18.1	9.63	5.66	2.54	11.7	15.4

* $\frac{\text{Vehicle}}{\text{Wagon}}$ miles have been reckoned in terms of 4-wheelers.

The above figures have been calculated from fundamental data given in the Railway Board Administration Reports.

Another disturbing feature is that, as will be seen from Tables A and D, the number of Broad Gauge and Metre Gauge hot boxes has risen in spite of a reduction in vehicle miles.

Table D.

* $\frac{\text{Vehicle}}{\text{Wagon}}$ miles (in millions).

Year.	Broad gauge		Metre Gauge.		Narrow Gauge		All Gauges.	
	Vehicle	Wagon.	Vehicle.	Wagon	Vehicle.	Wagon.	Vehicle.	Wagon.
1927-28 ...	1,140	2,120	576	825	36	35	1,752	2,980
1928-29 ...	1,175	2,154	582	830	38	38	1,795	3,022
1929-30 ...	1,199	2,079	622	817	42	38	1,863	2,934
1930-31 ...	1,167	1,988	616	776	42	38	1,825	2,802

* $\frac{\text{Vehicle}}{\text{Wagon}}$ miles are in terms of 4-wheelers.

The only specific information to which the Committee has had direct access is that furnished by the G. I. P. Railway ; and they, therefore, limit their remarks in detail to the action taken by that railway.

The first step was to classify hot boxes under a variety of headings, such as :—

- (i) Home or Foreign Stock ;
- (ii) Up or Down traffic ;
- (iii) Loaded or Empty ;
- (iv) Division, Railway or Workshop responsibility ;
- (v) Period elapsed since last repacking date ;
- (vi) Cause of the trouble ;

and so on. One of the many points brought to light by the analysis of these details was the fact that large numbers of bearings failed through defects in technique quite apart from lubrication.

For example, it was shewn that

- (a) bearings will almost certainly fail prematurely unless the white metal is thoroughly well 'tinned' on to the shells :
- (b) the accurate fitting and equalising of end play has a direct influence upon the rate of wear, and (almost as certainly) upon the incidence of 'waste grabs' ; and
- (c) it is extremely doubtful whether the existing standard carriage and wagon white metal alloy can be relied upon for the three years and three months service it is expected to give.

The Committee recommend that, in view of the economies in operation that would follow upon success in reducing the incidence of hot boxes, a co-ordinated attack on this subject should be organised through the Indian Railway Conference Association after collecting from railways all the information and ideas on the subject that are available up-to-date.

(vii) Utilisation of scrap.

The Committee feel that large economies can be effected if proper enquiries are made and action co-ordinated to ensure the fullest possible utilisation of scrap.

Scrap found on scrap heaps and in stores depots usually comes under the following headings :—

- (a) Scrap which is useless for railway purposes and cannot be worked up by railways themselves ;
- (b) Scrap which can be worked up by railways ;
- (c) Scrap which is at present being used by certain workshops, but not to the fullest extent ;
- (d) Reclaimable materials ;
- (e) Obsolete fittings.

In category (a) will be found such materials as condemned engine frames, condemned boilers from which the copper fire boxes and tubes have been removed, scrap steel castings, mixed borings, perished rubber fittings, etc. ; and regarding these, the Committee pass no comments.

NOTE A.

Results of tests carried out on rolled second-hand Carriage and Wagon axles, and rolled scrap engine and tender axles.

Price list No.	Rolling Mill Identification number	Analysis.						Mechanical Tests.				Bend Tests.	Scleroscope Hardness Nos.
		C %	Si %	S %	P %	MN %	Maximum Stress (Tons)	Elongation %	Reduction of Area.	Fracture.			
<i>Second-hand C. & W. Axles 9" X 4".</i>													
Eb. 1	... ...	52x	.37	.161	.023	.036	.78	35.34	28	57.6	Fibrous cup good	180"	19/26
"	... ...	53x	.29	...	...	...	.75	31.52	28	57.6	Fibrous	Satisfactory.	20/30
"	... ...	54x	.32	...	...	...	.72	32.54	27	56.0	"	...	23/26
"	... ...	55x	.42	...	...	...	.67	35.94	26.3	54.2	Fibrous v. g. cup	..	28/30
"	... ...	56x	.28	.114	.020	.032	.75	32.54	29	59.2	Fibrous	..	22/33
"	... ...	57x	.35	...	...	...	1.00	35.74	27	56.0	Fibrous v. g. cup.	..	21/25
"	... ...	58x	.27	...	...	...	.78	32.54	27.5	59.2	Fibrous ..	..	23/34
"	... ...	59x	.22	...	...	...	1.25	34.34	26.5	60.8	"	..	25/28
"	... ...	60x	.37	...	...	...	.80	39.96	20.0	54.2	"	..	30/25
"	... ...	61x	.32	.142	.019	.027	.60	32.54	18.8	59.2	"	..	27/34
<i>Scrap Engine Axles.</i>													
Gb. 4-155	... No. 1	30	...	...	...	...	.51	36.16	21.2	49.6	Fibrous ..	..	24/25
"	... No. 2	33	...	...	...	...	.65	33.54	29	57.6	Fibrous cup g. ..	..	...
<i>Scrap Tender Axles.</i>													
Gb. 4-155	... No. 1	38	...	...	...	...	.52	32.74	28.5	60.8	Fibrous cup g. ..	..	25/29
"	... No. 2	35	...	...	...	...	.82	35.34	26.5	56.0	Laminated.	.....	...

NOTE B.

Statement showing average annual consumption of certain items of permanent way, for scattered renewals.

Permanent way items.	Quantity.		I. R. S. specification No.	Mechanical Tests.		Bend Tests.	Analysis.				
	Numbers.	Ton-nage.		Tensile strength per sq. in. (in tons).	Elongation %		Carbon. %	Silicon. %	Sulphur. %	Phosphorus. %	Manganese. %
Fish Plates	...	9,630	86	T 1-31	36-42	20	120°	.30-.42	0.15	.06	.06
Tie bars	...	12,800	143	T 8-30	Min. 20	15	180°	...	...	Max. 08	Max. 08
Gibs	...	54,000	6	T 8-30	Min. 20	15	180°	...	...	Max. 08	Max. 08
Cotters	...	66,400	15	T 8-30	Min. 20	15	180°	.12-.20	Max. 20	Max. 05	Max. 05
Keys steel for F.F. rails	...	22,750	18	T 8-30	28-33	20	180°	...	...	Max. 06	Max. 06
Keys steel for B.H. rails	...	2,69,000	272	T 8-30	28-33	20	180°	...	...	Max. 06	Max. 06
Kidney pieces	...	104	0.06	T 8-30	28-33	20	180°	...	...	Max. 06	Max. 06
Fish bolts	...	45,000	40	T 3-30	35-40	20	180°	...	...	Max. 06	Max. 06
Crossing & Check bolts	...	13,500	18	T 3-30	35-40	20	180°	...	...	Max. 06	Max. 06
Chair bolts (or Fang bolts)	...	1,19,000	173	M 1-30	28-33	20	180°	...	...	Max. 06	Max. 06
Stud bolts	...	700	0.8	...	28-33	20	180°	...	...	Max. 06	Max. 06
Spikes Dog	...	29,500	11.5	T 2-30	25-30	25	180°	...	...	Max. 06	Max. 06
Spikes Round	...	1,02,500	57	T 4-30	25-30	25	180°	...	...	Max. 06	Max. 06
Total	...			840							

With regard to (b), there is at present no uniformity, even between State Railways, in the matter of working up scrap. For instance, on the East Indian Railway, laminated engine springs (with the exception of the top plates and buckles) are manufactured from scrap tyres at a cost which is approximately half the price of purchased springs. The tyres are rolled into spring plate in the Rolling Mill, which is in a position to undertake additional work for other railways. If more condemned tyres were used for this purpose, considerable savings would be effected. Condemned straight axles are used by certain railways in the manufacture of drop stampings, and we understand that the results obtained are satisfactory; but, in spite of this, large quantities of scrap axles are auctioned yearly. Inset—note (A)—is a statement showing the results of tests carried out on rolled sections made from scrap axles. It will be seen that these rolled sections comply with the specifications for class III steel. Inset—note (B)—is a statement giving the annual requirements of the G. I. P. Railway for certain permanent way fittings, with the relevant specifications. As these specifications correspond closely to the results shown in note (A), the Committee consider that an attempt should be made to manufacture permanent way materials of the classes specified from scrap axles, as the price of such fittings has been estimated to be approximately half the present rates.

The Committee understand that the Jamalpur Rolling Mill is in a position to give the required assistance, and they suggest that trial orders be placed to enable the fittings to be thoroughly tested to see whether the specifications can be met.

Category (c) refers principally to cast iron scrap and non-ferrous scrap. Recent investigations on one railway have resulted in stronger and cheaper castings being manufactured by using a larger proportion of cast iron scrap combined with a proportion of mild steel scrap; notable examples being cast iron sleeper plates and cast iron piston heads. It is probable that other railways have made experiments on similar lines with success, and the Committee feel that the results of these experiments should be communicated to the Railway Board for circulation and adoption by other railways. When it is borne in mind that some of these experiments have resulted in less than half the quantity of pig iron being used, it will be realised what large savings can be effected, as the price of pig iron is approximately Rs. 57 per ton, as compared with Rs. 20 per ton for cast iron scrap. Investigations on non-ferrous castings have also resulted in considerable economies. The specifications laid down for non-ferrous castings merely indicate the final analysis, and successful results depend upon the use of suitable pot mixtures. It is here that economies can be effected by proper research, as any increase in the scrap content will immediately result in much cheaper castings owing to the wide difference between the cost of virgin metals and the corresponding scrap rates.

With regard to (d), reference is made at a later stage to the measures proposed for preventing serviceable material from reaching the scrap heap, but nevertheless it is considered that each Stores Department Depot should have a Reclaiming Section under the charge of a competent mechanic, who would be responsible for examining all scrap returned and removing any materials or parts which can be used or profitably repaired in the workshops. For example, complete buffers are often found on the scrap heap, although only the spindle is broken or the casing cracked, and similarly, screw couplings are often scrapped for a broken shackle, or springs for a broken top plate. There are various items which can be repaired by electric welding and others which can be turned down and used for smaller sizes, e. g., piston rods.

With regard to (e), the Committee are of opinion that certain alterations have been effected from time to time without due regard to the amount of new and serviceable fittings that would be rendered obsolete in consequence. It is recom-

mended that orders be issued that no alteration (unless connected with public safety) should be effected until all existing stocks of fittings have been issued, unless, of course, it can be proved that a saving will result from scrapping such fittings immediately in favour of the new design. This point is referred to on page 33 section 3 (v).

There is no doubt that the Survey Committees which have been appointed on the various State Railways have been able to effect considerable economies, but at the same time it is considered that what is required is an organisation to prevent serviceable materials being returned as scrap. A point which impressed the Committee, was the amount of serviceable material which had found its way to the scrap heaps, although similar material was noticed in stock in Stores Depots.

In our opinion, the Main Survey Committees, while performing a very useful function, act too late in the day to prevent returning officers from recouping supplies against serviceable materials returned, and the Committee, therefore, recommend that Sub-survey Committees should be appointed at workshops, sheds, and other main returning centres. For workshops, it is suggested a Committee composed of two foremen with the Production Engineer as President should be set up and other departments should model their arrangements on this. These Sub-Survey Committees should be made responsible for inspecting all scrap which it is proposed to return to Stores and certifying it as unserviceable in the same manner as the Main Survey Committees would have to do at a later stage. If this suggestion is adopted, the Main Survey Committees will then function more as inspectors of the work of these Sub-survey Committees and by bringing to notice any neglect in this matter should ensure good results.

To sum up the Committee recommend that—

- (1) in order to see whether scrap tyres and axles can be utilised more extensively, trial orders should be placed for springs and for suitable sections to be used in the manufacture of permanent way fittings;
- (2) the results of experiments having for their object the greater utilisation of cast iron and non-ferrous scrap should be circulated to all railways through the Railway Board;
- (3) Reclaiming Sections should be established at Stores Department Depots;
- (4) alterations, before being effected, should take into account the material which will be rendered obsolete; and
- (5) Sub-survey Committees should be appointed at main returning centres.

(viii) Accounting as an aid to efficiency.

The Committee consider that the close attention paid in recent years to the statutory functions of the Accounting Department and the numerous investigations which have been made into the system of railway accounting in India have emphasized these functions to the detriment of the equally important executive functions of that department.

The unanimous opinion expressed by the higher railway officials and the executive officers with whom the Committee have had opportunities of discussing this question was that the present accounting system failed to meet departmental

executive requirements. Throughout their investigations, the Committee were impressed by the room for improvement in co-operation between the executive and the accounting departments. The Director of Railway Audit expressed a similar view in his report on the Appropriation Accounts for 1930-31.

The Committee are particularly concerned with the functions of the Accounts Department in so far as they affect the administrative and executive officer. This point will be elaborated at a later stage.

Briefly, the functions of the Accounts Department should be three-fold :—

Statutory : i.e., accounting for expenditure and revenue in accordance with the Codes prescribed by the Government of India;

Administrative : i.e., advising the Agent in matters relating to the general finances of the railway; and

Executive : i.e., compiling for administrative and executive officers such figures and statistics as may be necessary to guide them in obtaining the highest possible efficiency.

A great deal of time has been spent and much has been written since the days when the Acworth report was published in defining and describing the statutory functions of the Accounting Department. The subject, in one form or another, still holds the attention of the experts and is a prolific source of reports, theses, notes, governmental and administrative orders. It has been prescribed that the Chief Accounts Officer should be responsible to the Controller of Railway Accounts (and Financial Commissioner) for his statutory functions. The Committee have no comments to offer on this point.

It has also been prescribed that the Chief Accounts Officer should be the Agent's adviser in administrative matters. While, in theory, one might expect the authority of the Controller of Railway Accounts to exist only in the background (corresponding to the influence of auditors upon directors controlling the finances of a public company), in practice, on State Railways, the authority of the Controller of Railway Accounts extends right into the foreground even in matters of administrative and executive control. For example, if an Agent were advised by a Head of Department that it was desirable to introduce a system of combining accounts and statistics in a particular workshop, and that this would involve more than an incidental expenditure of funds upon staff and equipment, it would be necessary to approach the Controller of Railway Accounts for sanction even if the scheme were supported by the Chief Accounts Officer. It is not suggested that the Controller would reject such a proposal, but it seems perfectly clear that in administrative matters, the Agent and the Agent alone, should be the controlling authority except, of course, in matters involving State Railway policy.

Another reason for the breakdown of the existing organisation is the lack of appreciation of the scope of the financial advice which a Chief Accounts Officer of a State Railway may give, and the extent to which his functions (as an adviser to the Agent) may cut across the functions of the other Heads of Departments. It is one thing for a Head of Department to scrutinise departmentally (with a view to control) the divisional monthly budgets ; the matter assumes an entirely different aspect immediately this control overflows into the Accounts Department. It is not for the Chief Accounts Officer to usurp the proper functions of Heads of Departments.

As regards the executive functions of the Accounts Department, the Acworth Committee recorded their opinion that :—

“Economical railway management cannot be ensured without a proper system of railway accounting. Apart from a mere audit check of receipts and disbursements, a railway requires a large number of financial returns of various kinds : not in order to say whether expenditure incurred has been duly authorised, or receipts duly accounted for, but to say whether expenditure is being wisely incurred, whether retrenchment of habitual expenditure is possible under one head, whether new expenditure under another is proving profitable, or even whether a larger expenditure would be likely to be fruitful and so on. These are not matters to be left to an outsider. A practical railway man who knows what he is doing in the present, and what changes he is meditating for the future, is alone competent to prescribe and to make use of returns of this kind.”

Sir Arthur Lowes Dickinson endorsed this opinion and in his report stated that :—

“The Agent and other railway officials who are responsible for the economic and efficient operation of the railway have no control over their own accounts or their Chief Auditor, and while the latter is expected in a general way to assist the operating officials, my experience and observations have led me to the conclusion that there has never been that close co-operation between the two that would have existed under a different organisation.”

* * * *

“In spite of explicit instructions in the regulations, it does not seem to be fully realised in actual practice that the relations between the Chief Auditor of the railway, who is also Chief Accountant, and the operating officials should be of the most helpful kind, as in the case of commercial concerns, and that the first business of the accountant is to prepare and furnish to the operating officials such accounts and statistics as they may require, and to help them in every way in the efficient operation of the railway.”

* * * *

“..... the complete divorce of accounts from operation has contributed to the delay in presentation of accounts, with the result that operating officials have been forced into keeping more or less accurate accounts for themselves which should have been regularly supplied by the Accounting Department.”

* * * *

“For this purpose it is essential, firstly, that the form in which the results are presented should be such as will best convey to the operating officials the information which they want. The accounting officers are specially skilled in accounts and figures, and in the mode of their preparation and presentation, and it is their duty to use their special qualifications in the first instance solely for the purposes indicated. Secondly, in order to be of use, this presentation must be made with as much speed as possible so that the operating officials may see the results of their work promptly and so be enabled to remedy any errors in administration (technical or commercial) which may be disclosed by these figures.

If the accounting officers have not this first and most important duty clearly before them, it must result (and, in fact, has resulted in the past in the case of the Indian Railways) that the operating officials will endeavour

to get out for themselves, and without the assistance of skilled accountants, the figures which they require. The figures so obtained are duplicated by the accounting staff at a much later date, and thereafter time and money is expended in agreeing the two sets of results. A proper system of accounting would avoid this duplication, and, at the same time, would give the operating officials of the railway accurate, or approximately accurate, results at an earlier date than the unproved figures which they have been in the habit of preparing."

* * *

The Legislative Assembly accepted the advantages of these proposals in 1925 and again in 1929.*

One of the serious practical defects of the existing system of organisation is that, so far, the co-ordination of data relating to efficiency has been left to the executive officers. In other words, the data presented at present fails to exhibit the efficiency factor $\frac{\text{Cost}}{\text{Work done}}$.

The Committee recommend that the compilation of all 'cost' and 'performance' data should be done by the Accounting Department for other departments. An attempt should be made forthwith to introduce a co-ordination of accounts and statistics on one State Railway on lines that best will serve the needs of the executive officers in securing the maximum of efficiency of working. The system evolved should serve, as far as possible, as a model for introducing similar arrangements on other railways. It is hoped that it will be clearly laid down that the interpretation of this data is a matter for Agents and Heads of Departments, and that the Statistical Officer should be under the Agent.

The following items shew the type of managerial difficulties arising from the existing lack of co-operation between the Accounts and other Departments:—

- (1) Delays occur in disposal of references and closing of accounts.
- (2) Erroneous allocations are made.
- (3) Mispostings are numerous.
- (4) Adjustment entries are high.
- (5) Raising of debits is delayed.
- (6) Approximate figures of monthly expenditure are not furnished and final figures are supplied six weeks or more after the period to which they relate.
- (7) Percentage of unimportant points in objection statements is high.
- (8) Duplication of accounting work exists between departments.

Whether these faults are caused by errors and delays in the submission of basic documents by the departments concerned to the Accounts Office or whether they are due to errors and delays in the latter is not the immediate question. The point is that they can only be rectified by co-operative measures.

The Committee consider that the Chief Accounts Officer should be definitely under the Agent (subject to the reservation regarding statutory control). They feel that unless this is clearly laid down, the preparation of managerial information cannot be carried out on co-operative and co-ordinated lines and the Chief Accounts Officer cannot take his proper place in the organisation of the railway. The Chief Accounts Officer's function of keeping the statutory accounts in an efficient and economical manner, for which he is responsible to the Controller of Railway Accounts, is hardly more important than his function in connection with management. He has no incentive today to assist a concern to whose chief he is not responsible, and it is not altogether surprising that complaints exist. A mere instruction from the

* Railway Retrenchment Sub-Committee's Report, October 1931, pages 20 and 21, para. 64.

Railway Board to the Chief Accounts Officer to co-operate would not be sufficient (such a recommendation * was in fact reiterated some time ago, but with no appreciable results): what is wanted is the fundamental change in responsibility advocated.

Another important point arises in connection with accounting as an aid to efficiency. On page 21, in connection with job analysis in main workshops, the Committee referred to the difficulty of comparing the unit costs of engine and rolling stock repairs of one railway with those of another owing to the lack of uniformity in the accounting systems in force. The Committee have taken evidence which shows that

- (1) the definition of 'supervision' is not the same on all Railways;
- (2) the method of charging overheads varies; and
- (3) the manner of distributing profits which arise in the course manufacturing operations often differs.

The Committee are not concerned with the technical aspect of the case, i. e., which railway is following most closely correct accounting procedure: but they feel that, unless and until uniformity is established, the value of the statistical returns for workshops is limited, in that an element of doubt must enter into any deductions based upon the published costs. In view of the important questions of policy that may hinge on these deductions, it is obvious that the matter merits very close attention.

The Committee recommend that a small Committee of Works Managers and Workshop Accountants should be set up to effect standardisation of procedure in workshop accounting.

4. RETRENCHMENT.

On page 49 of Railway Board Administration Report, 1930-31,† the cost of staff on Indian Railways is given as Rs. 39,92,20,220. On page 10, the working expenses are given as Rs. 54,38,94,000. The percentage of staff cost to working expenses was 73 per cent. Every operation which is eliminated, or more economically carried out, almost invariably means that less staff is required. The figures above illustrate that one of the main avenues of economy is reduction in personnel.

It is the view of the Committee that, not only are there numbers of surplus men on the railways to-day but that if their recommendations are adopted, these numbers will be considerably increased. Wastage, and the attraction of enhanced retiring allowances (if granted), would certainly reduce this surplus to some extent; but the Committee wish to point out that the fewer the difficulties in disposing of surplus staff, the greater the incentive to railway officers to examine their organisations with a view to an economic complement of personnel being maintained. At the present time, unnecessary tools and stores are being used; work is being done which is unnecessary or might be postponed; delays take place in offices and discipline suffers generally. In other words, surplus staff means extravagance.

The Committee have to point out that most of the schemes for improved efficiency and economy recommended in this report will have the effect of increasing the numbers of surplus staff, and they request the Railway Board to bear this point in mind whenever they are considering any change in the policy of retrenchment.

The labour situation may be improved by a revival in trade, but experience has shewn that improved organisation and methods result in reductions in staff, and that, subsequently, if there is an increase in business, it is not always necessary to bring the complement of staff up to the former level for any given operation.

* Mr. P. R. Rau's Report on the Control of Expenditure on Indian Railways, 1930.

† The latest report available.

Nothing in this section of the report should be taken as indicating that the inauguration and progress of job analysis and other recommended arrangements should be delayed because any consequential staff re-arrangements cannot immediately be carried into effect. A job analysis may shew the proper complement for a given office : if it cannot be implemented because there are no means of disposing of the surplus staff, nevertheless, a standard will have been laid down for attainment as quickly as possible.

5. FINANCE.

Sir Josiah Stamp, in his address to the share-holders of the London Midland and Scottish Railway in February, 1932, said " Those of you who attended the meetings of the Company or read the proceedings will remember that I have laid stress on the fact that the wide schemes of re-arrangement which we had undertaken, accompanied by heavy outlay on new plant and equipment would have a growing value."

If the plant and equipment of a railway, or in fact, any industrial undertaking, is to function economically, money must be spent upon it to keep it in repair and up to date. If the recommendations in Sections 2 and 3 of this Report are approved, many schemes may be put up involving the application of the principle of spending money to save money.

Job analysis and the other arrangements recommended in this report will result in numbers of schemes—individually, probably of minor financial importance—being prepared in which, by spending a certain sum of money, certain savings may be effected. Many of these proposals will command respect in that they will be the result of detailed analysis of the relevant factors, and will have been produced or scrutinised strictly from the net revenue point of view. It is important that the Railway Board or the Agents of the Railways should make such financial arrangements that the minimum delay will occur in effecting these savings.

6. AMALGAMATION OF RAILWAYS.

The economies obtainable through amalgamation of railways into a number of groups are so evident that the Committee cannot conclude their report on possible improvements in efficiency and economies in the operation of railways in India without reference to the question.

In Bombay, for example, the economies derivable from amalgamations of workshop resources, accounting staffs, etc., between the Great Indian Peninsula and Bombay Baroda and Central India Railways are obvious. Somewhat similar circumstances exist in the Calcutta area with respect to the East Indian and Eastern Bengal Railways.

Amalgamation can be achieved in two ways, either by combining into one railway, two, or more, existing railways, or by a regrouping of existing railways or portions of existing railways in entirely new groups of railways. The Committee are not, of course, in possession of all the relevant factors and circumstances, but there is one particular feature which they feel should receive consideration, *viz.*, the need of a close study of the matter well in advance of any fundamental change, so that any action taken is in accordance with a preconceived plan.

Great Britain and Germany have passed through the difficult phase of amalgamating their railways from a number of different undertakings into four and one respectively. In the United States, large amalgamations are contemplated.

The Committee consider that the questions arising in schemes for amalgamation should be studied in advance in the light of the experience gained in the various countries in which such schemes have been put into effect, by experienced officers representing commercial, operating, civil and mechanical engineering interests.

Amalgamation would be immensely simplified, and the resultant economies realised the quicker, if prior studies were made to discover the most efficient standard practices and organisation and how best to progress the schemes so that, stage by stage, finality is reached with a minimum of dislocation and an avoidance of unsuitable methods.

7. CONCLUSION.

The Committee wish to acknowledge the courtesy, and help in many matters, including office accommodation and clerical assistance, rendered to them by the Agent and Officers of the Great Indian Peninsula Railway.

The Committee's conclusions and recommendations are summarised in the beginning of this report.

The whole tenor of the recommendations is that maximum efficiency and economy on Indian Railways can be secured only by constant organised research and investigation into every man hour and every item of material used, and that no saving is too small to be ignored.

F. A. POPE, *Chairman.*

J. A. BELL.

* C. F. CARSON.

R. C. CASE.

G. S. G. HIGGINSON.

G. A. R. TRIMMING.

18th February, 1933.

* During the interval between discharge from hospital and departure on medical leave, Lt. Col. Carson had the opportunity of studying a draft of the report and signed it in token of his agreement with it.

APPENDIX.**GREAT INDIAN PENINSULA RAILWAY.****Agent's office.**

*Victoria Terminus.
Bombay, 6th January, 1933.*

No. Con. 342/26.

Chief Accounts Officer.

Chief Engineer.

Chief Transportation Superintendent.

Chief Traffic Manager.

Chief Mechanical Engineer.

Controller of Stores.

Principal Medical and Health Officer.

*Dear Sir,***Job analysis.**

As you are aware, it has been decided to inaugurate a series of systematic analyses of different operations and activities on this railway, and I indicate below details and lay down certain instructions in connection therewith.

2. "Job analysis", as the title implies, means detailed enquiry into operations of every kind performed in offices, workshops, depots, yards, locomotive sheds, and those performed by artisans or other men working on the line, with a view to ascertaining whether particular functions are economically carried out, can be eliminated altogether, or amalgamated with other activities. It aims at enabling—

- (1) comparisons to be made between similar operations at A and B;
- (2) the best practice for particular work to be tabulated and adopted elsewhere;
- (3) waste of money and effort to be eliminated.

3. It is, of course, true that occasional analyses of operations have been made in a number of cases, but there has been no systematic co-ordinated application of the principle, and I am quite sure that considerable economy will result if this is done.

4. In undertaking a campaign of this kind it is clear that there must be coordination in matters where two or more departments are concerned, and that experience gained and results obtained must be recorded to ensure that a good avenue of attack or technique of investigation developed in one department may be available for others.

5. In order that "job analysis" may be carried out on systematic lines, the following arrangements will be made—

- (i) Mr. Case will be attached to my office and work directly under me.
- (ii) Mr. Case will discuss with each Head of Department the directions in which and the methods by which "job analysis" will be applied in each department and will obtain particulars of the existing methods of assessing man power or relating expenditure to requirements. He will arrange with the Heads of Departments (or their representatives) the particular staff required to undertake the necessary investigatory work.

- (iii) As regards questions affecting more than one department, Mr. Case will consult with Heads of Departments concerned (or their representatives) as to the staff and methods to be adopted.
- (iv) Copies of the reports made under (ii) and (iii) will be furnished to the Heads of Departments concerned as they are made.
- (v) Mr. Case will report the progress made in each department to me periodically.
- (vi) Mr. Case must be supplied with the best available men in each department for job analysis.

6. It will be clearly understood that the scheme is not designed to find fault ; but to put things right and improve efficiency and save money. It must not be regarded as a reflection on a departmental head or divisional officer that analyses show that more economical methods can be employed. It is not often that you, or your deputies or divisional officers, have been able to organise particular special enquiries, and the scheme outlined herein aims at providing you and me with a new arm or unit of the organisation for investigation purposes. It offers an opportunity of obtaining higher standards of efficiency than have been possible hitherto, and will ensure that such are maintained. Moreover, it should result in a number of men becoming more valuable to the Administration by reason of their training in analytical work.

7. Eventually efforts will be directed towards the development of a technique of investigation so that, at a later stage, officers in charge of units of the organisation can be furnished with forms, or details, to assist them to do their own job analyses.

8. It will be necessary for Mr. Case and the analytical staff to visit offices, stations, workshops, etc., and I shall be glad if you will give instructions that they are to be rendered every assistance.

9. In conclusion, I wish to point out that it is imperative that the personnel selected for "job analysis" should have faith in the idea and that they should be thorough in their work. The whole success of analysis depends on the proper recording, sifting and analysis of a mass of detail and I rely on your earnest co-operation.

Yours faithfully,
 (Sd.) A. E. TYLDEN-PATTENSON,
Agent.

